TECHNOLOGY REVIEW

March 1955

TECHNOLOGY DEPT.

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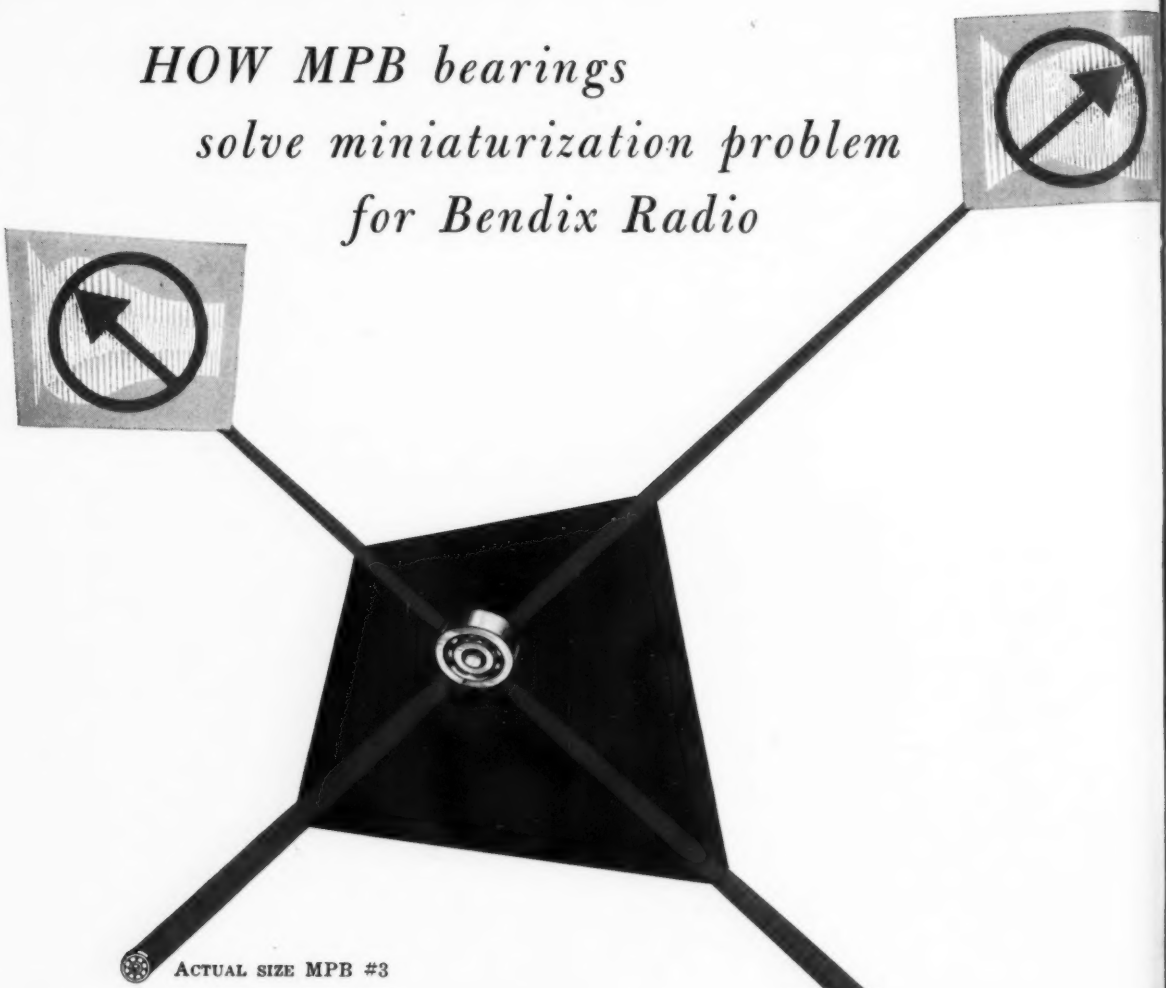
HOW MPB bearings solve miniaturization problem for Bendix Radio



ACTUAL SIZE MPB #3

MPB ball bearing used as Index Pawl in miniature frequency selector switch

OPERATING CONDITIONS — miniature ball bearing serves as index pawl in 4-position indexing device . . . bearing travels at 936 r.p.m. CRITICAL — low starting torque, low friction rotation . . . high impact loads . . . long, trouble-free bearing life. RESOLVED — by use of MPB No. 3, .1875" o.d. full-race bearing.

To quote Mr. John F. Wroten, Jr., mechanical engineer with Bendix Radio Division, these are some of the reasons why MPB bearings were selected in the miniaturization of their frequency selector switch: "The low friction rotation of the bearing practically eliminates drag in the indexing action, and reduces to a minimum the amount of power required for disengagement. Also, the bearing displays unusually high resistance to the frequent impact loads a detent stop of this kind must withstand . . . . Because rolling contact occurs between the pawl and the plate, the plate can be made of soft stainless steel."

For problems involving miniaturization, consult MPB, pioneer manufacturer of miniature ball bearings.

Miniature *Precision* Bearings, Inc., 103 Carpenter St., Keene, N. H.

MPB

LION OIL COMPANY

LION

EL DORADO, ARKANSAS

J. B. ROGERSON,
MANAGER OF MANUFACTURING

MANUFACTURING DIVISION

October 29, 1954

LUMMUS

DATE REC'D:	NOV. 1, 1954
ROUTE TO:	C.A.B.
REMARKS:	

Mr. C. A. Barrere
Vice President
The Lummus Company
2707 Weslayan
Houston 6, Texas

Dear Mr. Barrere:

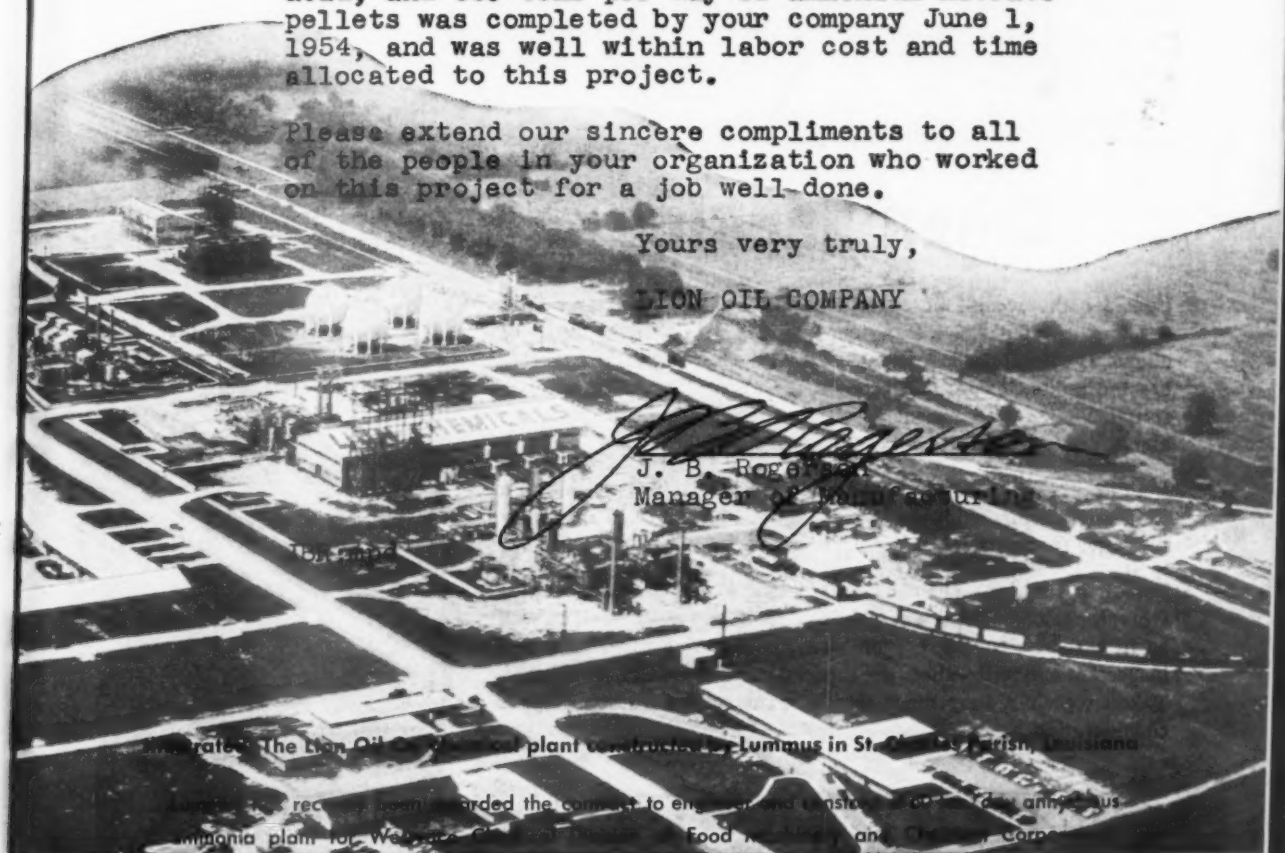
The construction of our chemical plant in St. Charles Parish, Louisiana, to produce 300 tons per day of ammonia, 450 tons per day of nitric acid, and 550 tons per day of ammonium nitrate pellets was completed by your company June 1, 1954, and was well within labor cost and time allocated to this project.

Please extend our sincere compliments to all of the people in your organization who worked on this project for a job well-done.

Yours very truly,

LION OIL COMPANY

J. B. Rogerson
Manager of Manufacturing



Illustrated: The Lion Oil Company ammonia plant constructed by Lummus in St. Charles Parish, Louisiana

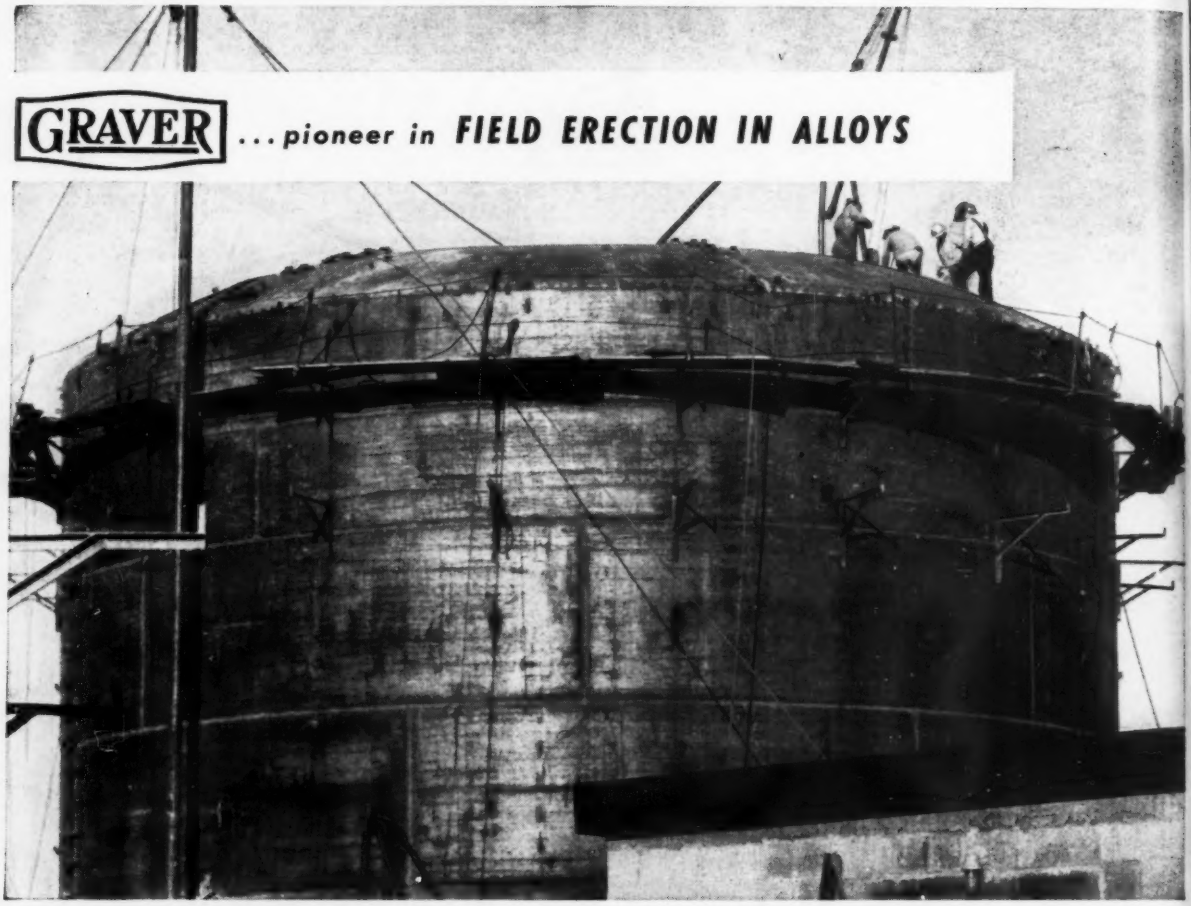
Lummus has recently been awarded the contract to engineer and construct a complete ammonia plant for Wilson Food[illegible] and The [illegible] Corporation

THE LUMMUS COMPANY, 385 MADISON AVENUE, NEW YORK 17, N. Y.

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

THE TECHNOLOGY REVIEW, March, 1955, Newsstand Edition. Vol. LVII, No. 5. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $4.00; Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office at Bristol, Conn., under the Act of March 3, 1879.

GRAVER ... pioneer in FIELD ERECTION IN ALLOYS

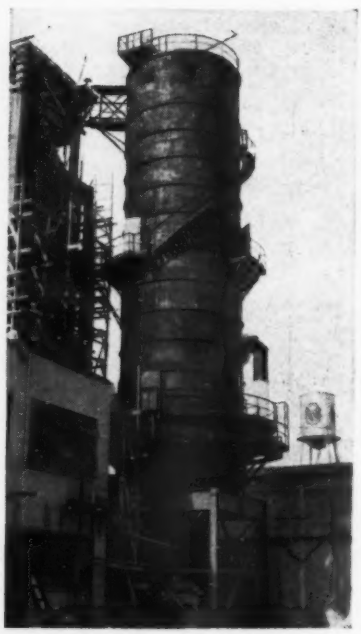


When Seeking a Source...

Consider the wealth of experience Graver has gained in field erection in alloys . . . experience that dates from the birth of alloys. It is standard procedure for Graver to build large, site-erected tanks, towers and process vessels of every size and description—like the large nickel-clad tank for storing caustic shown above, and the intricate spray tower on the right.

Both in this country and abroad, Graver has acquired a reputation for fine craftsmanship, plus a unique ability to more than satisfy customer demands.

For all industries—chemical, petroleum, food, pharmaceutical—Graver fabricates in nickel, stainless, clads and aluminum, as well as in carbon steels. Precision work, painstaking care, intensive inspection methods—these are integral parts of the Graver method. Taken together, they mark Graver as a source worthy of your consideration.



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East Chicago, Indiana

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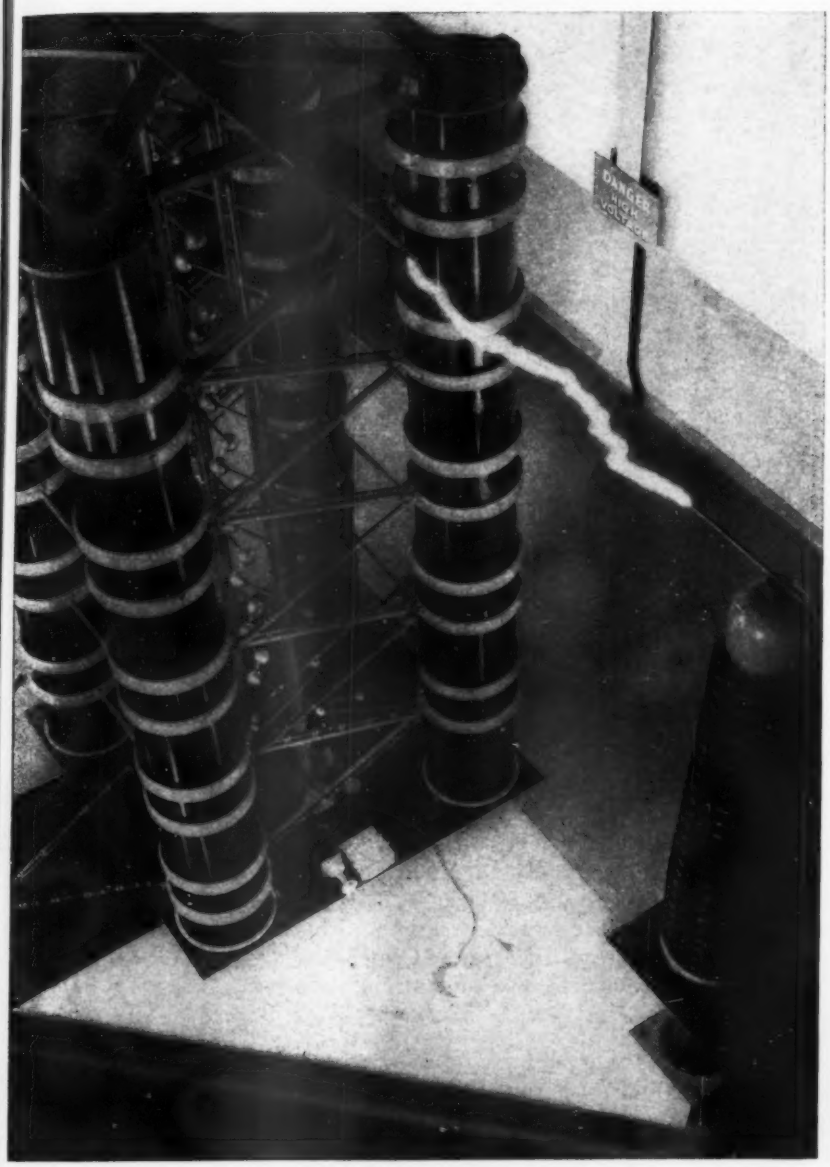
New Phelps Dodge Research Laboratory

PROVIDES FINEST HIGH VOLTAGE TEST FACILITIES



Modern utility systems are requiring progressively higher voltage underground cables to carry the constantly increasing power loads.

Phelps Dodge is fully equipped to meet these utility demands with its new high voltage laboratory in Yonkers, N. Y. This laboratory is provided with the finest power cable research and testing facilities and is staffed by skilled engineering personnel.

Typical example of this new equipment is the Lightning Generator, shown at left. This generator produces powerful electric discharges equivalent in magnitude and severity to natural lightning. It is capable of attaining surge currents of 30,000 amperes and test voltages up to 2,000,000 volts in less than a millionth of a second.

Ability of the various cable designs to operate continuously at the required extra high voltages is determined by 60-cycle alternating current tests up to 750,000 volts.

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Which packs a bigger kick—

Oddly enough, most people think of steam as packing a much bigger "heat" kick than water. The fact is that . . . cubic foot for cubic foot . . . at any given pressure . . . water contains far more heat than steam — more than 50 times as much, for example, at such a typical industrial process pressure as 110 lbs. per sq. in.

That's why we're in hot water—and like it

. . . in the business of making *hot water* boilers, that is. But not for producing the kind of hot water you're familiar with . . . we're talking about high-pressure, high-temperature water—up to 300 lbs. per sq. in. and 425° F. At such pressures and temperatures water offers important advantages over steam for large heating installations and for many process heating requirements. And Combustion has a boiler design that is ideally suited to the job of heating and distributing high-temperature water — the C-E La Mont Controlled Circulation Hot Water Boiler.

If you have a heating or process job that's suitable for high-temperature water, it will pay you to look into a C-E La Mont installation. As compared to steam, it will give you a far simpler and less expensive distribution system, substantially lower fuel and maintenance costs and many operating advantages, such as more uniform temperatures and better temperature control. Write our Hot Water Heating Department for further information. B-804

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Combustion Engineering Building
200 Madison Ave., New York 16, N. Y.

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WE ARE PROUD to become the newest division of the world's largest producer of automatic controls. Our experienced staff of design engineers, our modern manufacturing facilities and our precision instruments all match the high standards set by Minneapolis-Honeywell. We shall continue to maintain our leadership as a quality manufacturer of servo components for bombing and navigational computers, fire control systems and missile stabilization and guidance systems. Whether your applications are of a military, laboratory or industrial nature, you may rely upon our instruments for measurement and control to continue to remain unsurpassed in a precision industry.

Doelcam
A DIVISION OF MINNEAPOLIS-HONEYWELL

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BOSTON 35, MASS.

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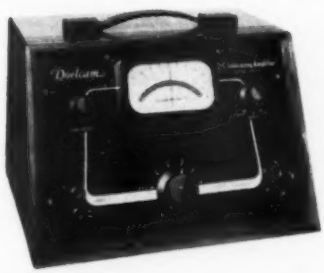
Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

SERVO MOTORS—All Navy Bureau of Ordnance Types—115 volts, 400 cps—fulfill rigid requirements of MIL-S-17087.

Write for Bulletin SM1

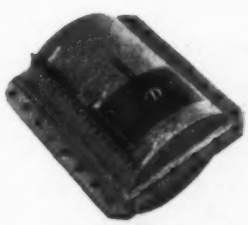
SYNCHROS—Sizes 11 through 31—115 volts, 400 or 60 cps—meet exacting requirements of MIL-S-16892 or FXS-1066.

Write for Bulletin S1



AMPLIFIERS—D-C Indicating Amplifier (shown here), Selected Range D-C Amplifier and Magnetic Null Indicator all use Doelcam Second-Harmonic Magnetic Converter in input stage for low drift and high sensitivity.

Write for Bulletin A1



GYROSCOPES—Cageable Free Gyro (shown here), Junior Rate Gyro, K Rate Gyro, Gyro Stable Platforms—used in guided missiles, aircraft flight evaluation systems and bombing and navigational computers.

Write for Bulletins K, JR, and CFG1

PHILOSOPHICAL LIBRARY BOOKS

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☐ **AN INTELLECTUAL PRIMER** *by Jay C. Knode.* A survey of the physical world and the universe of which it is part, tracing the advent of life upon the planet and its evolution to and including man. The author is Dean Emeritus of the College of Arts and Science, University of New Mexico. $2.50

☐ **DOWN TO EARTH** A Practical Guide to Archaeology *by Robin Place.* Fundamentals of dating, recording, and interpreting are described and there follows a detailed account of all the main kinds of "digs" and "finds", actual examples being drawn upon in each case. The author is Lecturer in Archaeology at the City Literary Institute. *90 Illustrations.* $7.50

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☐ **TWO YEARS IN THE ANTARCTIC** *by Kevin Walton.* This is the first personal account of two years spent in British Antarctica since the war. Kevin Walton went to the Anarctic as a member of the newly formed Falkland Islands Dependencies Survey and during his first year he trained himself and his dogs to live and travel in difficult country. The next year, an American expedition arrived and later both parties combined to complete an extensive survey of the East Coast of the Graham Land Peninsula. $4.75

☐ **BABA OF KARO** *A Woman of the Moslem Hausa by Mary Smith.* This remarkable book contains what is probably the first full-scale autobiography of an African woman. Mrs. Smith, who speaks fluent Hausa, became Baba's friend while her husband, Dr. M. G. Smith, a social anthropologist, was engaged in field work in Nigeria. After many conversations between the two women, Baba agreed to dictate the story of her life. Dr. Smith contributes an essay on Hausa life and sociology to provide the background. $7.50

☐ **CAPRICORN ROAD** *by Francis Balsan.* An unusual travel book, telling the story of the first expedition to cross Southern Africa from the Atlantic Coast to the Indian Ocean in 1951, sponsored by the Société Panhard and its South African representative Union-French Industries. The expedition rediscovered the Lost City to the east of the Nosop River, reported by Farini in 1885. This is a faithful account of the penetration of practically unexplored territory by man and machine. The team consisted of nine men (six Frenchmen and three South Africans) led by the author of this book, a well-known explorer and geographer. *Illustrated.* $4.75

☐ **ETRUSCAN ART** *by P. J. Riis.* This book is what might be called a collection of archaeological essays on the art from which Roman art was gradually developed, the art of the Etruscans, also the art of early Rome. The principal aim of the book is to widen the circle of knowledge already established by the university world and modern scholars in this particular field. Bibliographical notes added to the individual chapters will make the book useful to the student as well. The author is Professor of Archaeology at the University of Copenhagen. *Illustrated.* $10.00

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THE TABULAR VIEW

Limitations of Logic. – The increased complexity of technology and the need to properly assess the effects of science and engineering on man's life stimulate the need to examine the present status of engineering education. The requisite becomes all the more apparent when it is recognized (as reported on page 80 of the December, 1954, issue of The Review) that the nation's colleges and universities will face a bumper crop of students in the next decade or two. One study of engineering education is presented in this issue (page 233) by JOHN B. WILBUR, '26, Head of the Institute's Department of Civil and Sanitary Engineering. Despite the official position of the author, the views expressed by Dr. Wilbur are entirely his personal ones. Professor Wilbur makes an appeal for a "vertical type" of engineering training, in which logic and the informal faculties are developed simultaneously, in contradistinction to the horizontal type of training with "prerequisites." Professor Wilbur received S.B., S.M., and Sc.D. degrees from the Institute in 1926, 1928, and 1933, respectively. After two years in engineering practice, Dr. Wilbur returned to M.I.T. in 1930 as an instructor in Civil Engineering. He was made assistant professor in 1934, associate professor in 1937, and professor in 1943. He became acting head of his Department in 1944, and permanent head in 1946. Professor Wilbur is a member of the American Society of Civil Engineers and of the Boston Society of Civil Engineers. He is a fellow of the American Academy of Arts and Sciences, and an honorary member of Chi Epsilon, the honorary civil engineering fraternity. He is the author of many technical papers and bulletins and, with Professor Walter M. Fife, '21, of a textbook, *Theory of Statically Indeterminate Structures.*

Hold for Future Use. – A few rugged die-hards refuse to see the logic of that tail-chasing, economic shell game which requires our citizens to pay taxes in order that the government can keep agricultural prices up so that taxpayers' foodstuffs cost more than they would without government intervention. The farmers plant, reap, store –

(*Concluded on page 224*)

Take a leaf from past years.

Don't go around in circles.

Get squared for a good time.

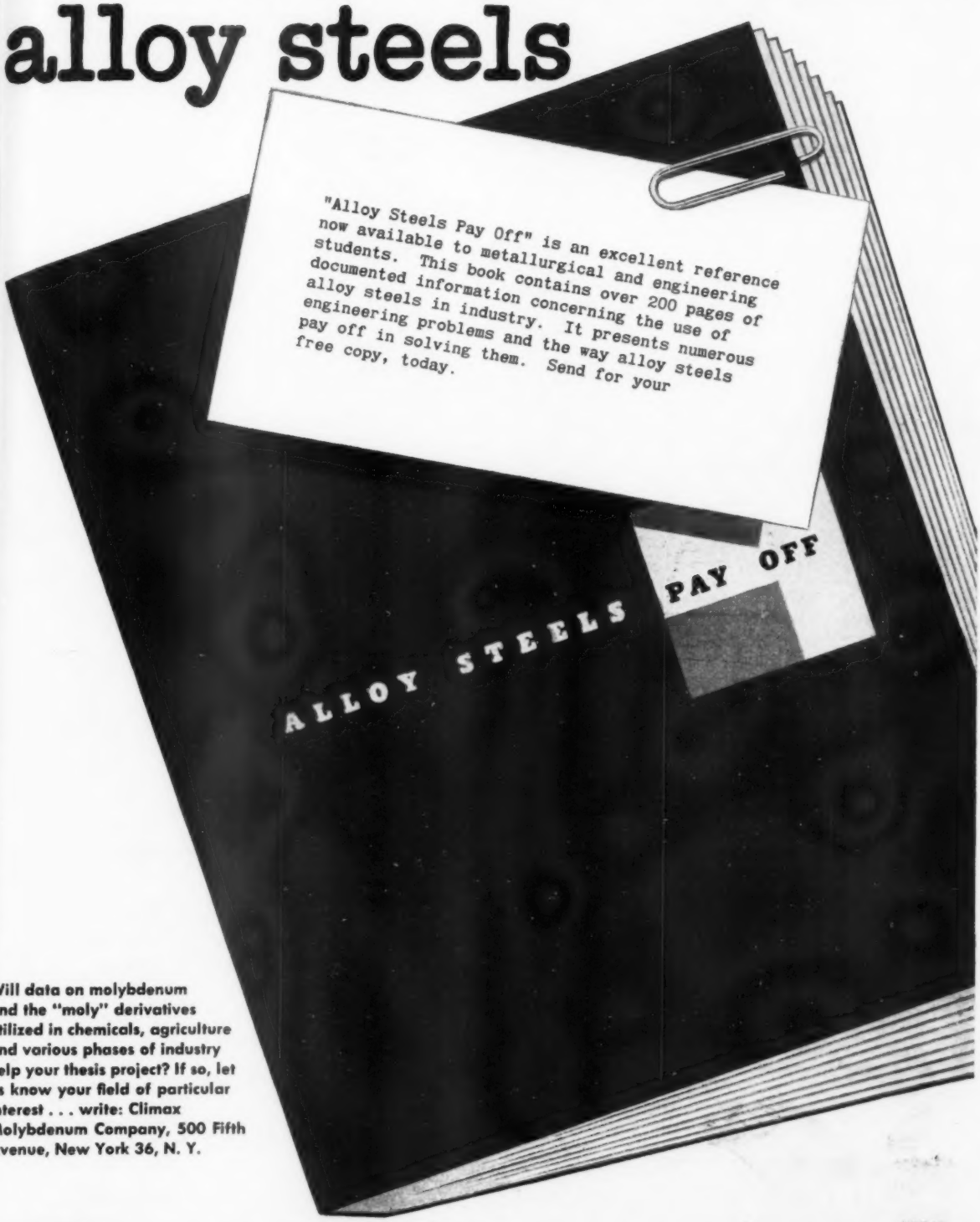
There is plenty of space for you.

A star program is being planned.

Check the date of June 13, for

ALUMNI DAY, 1955, at M.I.T.

60 case histories of alloy steels


"Alloy Steels Pay Off" is an excellent reference now available to metallurgical and engineering students. This book contains over 200 pages of documented information concerning the use of alloy steels in industry. It presents numerous engineering problems and the way alloy steels pay off in solving them. Send for your free copy, today.
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CLIMAX MOLYBDENUM

THE TABULAR VIEW

(Concluded from page 222)

and collect; the ordinary citizen faces increased taxation so that the cost of his food can be boosted; and the land becomes exhausted! The land now being overworked – to fill storage bins – will be sorely needed in another decade or two to feed our rapidly expanding population. A plan for conserving land is proposed by MILTON E. PARKER, '23, in "A Bumper Crop of Grass" (page 237). Professor Parker brings to his study a vast background of experience in the food industry. He received the S.B. degree in Industrial Biology from M.I.T. in 1923. He served as research associate at M.I.T. for a year under Samuel C. Prescott, '94 (now Professor of Industrial Biology, Emeritus), as dairy technologist of the Research Laboratories of National Dairy Products Corporation, manager of Beatrice Foods Company, as consulting food engineer, and, since 1948, as head of the Department of Food Engineering at the Illinois Institute of Technology. The stimulation and aid received from a similar article in *Lion Oil News* is acknowledged by Professor Parker.

Attila at the Door. – On every hand, throughout the land, we hear the plea that there should be more engineers, of youthful years, preparing for the next World War. The training of scientists and engineers in the U.S.S.R. has had a meteoric rise since the end of World War II, if numbers of enrolled students is a guide. In the United States, however, the number of college students enrolled in science and engineering has dropped steadily in the past few years. This drop in technical education – with Attila at our front door – is of concern to GEORGE TICHENOR who advocates (page 241) technical education for all it is worth. Mr. Tichenor believes that enrollment in science and engineering can be increased, but that we need to recognize that "science offers not only frontiers to be explored, but also the virginal beauty of a poem read for the first time." It will be surprising if Mr. Tichenor's thesis does not raise a few eyebrows – especially in liberal arts educational circles – but a good purpose will have been served if his views provoke others to recognize the nation's current educational needs. Since 1923 Mr. Tichenor has had a varied career as newspaper reporter and writer, editor, novelist, teacher, ghost writer, promotion director, and public relations adviser.

Canada Dry Ginger Ale, Inc.
New bottling plant,
Maspeth, N. Y.

Contemplating Plant Expansion?

From merely your own general description or outline of the proposed building, we can give you an estimate of the cost and time required to build – information that may be decidedly helpful to you in determining the desirability of proceeding, before you make any commitments.

W. J. BARNEY CORPORATION
Founded 1917
101 Park Avenue, New York
Alfred T. Glassett, '20, President

Farm-fresh to you...

How a remarkable plastic helps bring fresher food to your table

A WONDERFULLY useful plastic called polyethylene* is now giving a new kind of protection to food that is on its way to your kitchen.

WHEN FOOD IS PACKED in thin, strong bags of polyethylene, it is able to "breathe," and yet not dry out. Because polyethylene has this peculiar advantage, apples, carrots, and other fruits and vegetables—as well as poultry and meat products—can reach your table more nearly farm-fresh than ever.

POLYETHYLENE IS ONLY ONE of a number of plastics produced by the people of Union Carbide to help bring foods to you in prime condition. Some of these plastics coat cardboard for milk cartons and frozen food packages, while others line the tins for canned foods and beverages.

SCIENCE "SETS A GOOD TABLE" These and other materials produced by UCC help protect food while growing, in storage, during preparation, when packaged for your use, and when stored in your pantry or refrigerator. This protection helps provide a more healthful diet for all Americans.

STUDENTS AND STUDENT ADVISERS: *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Write for booklet A-2.*

*Pronounced pol'y-eth'i-lēn

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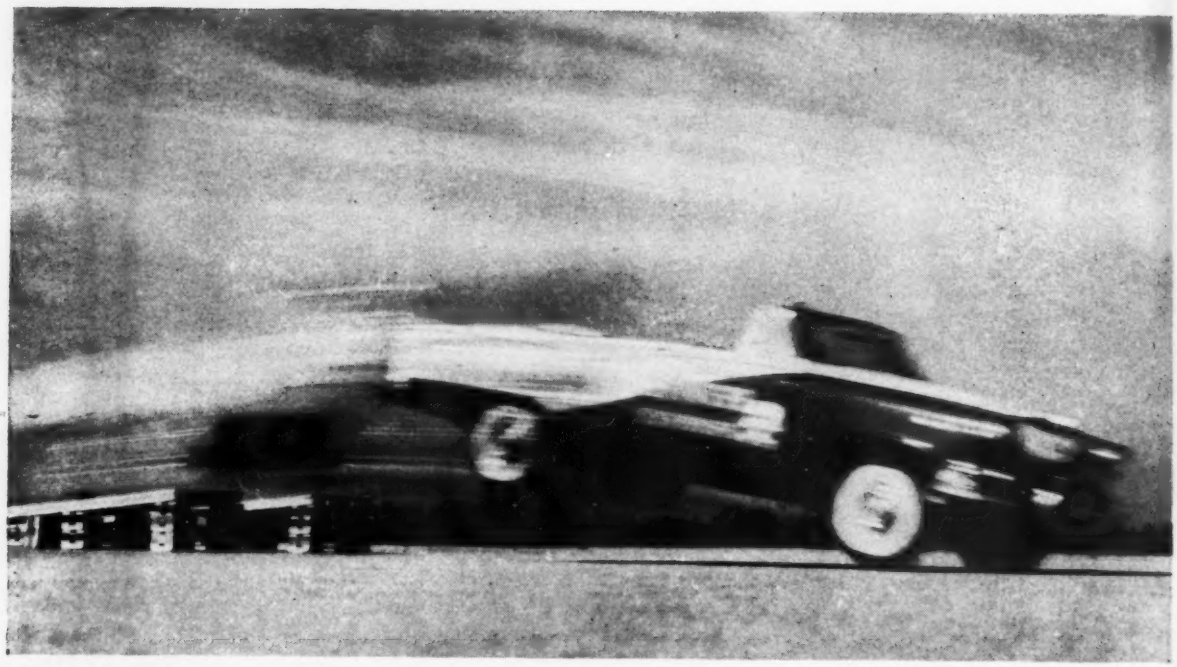
All-New Tubeless Super-Cushions give you

BETTER BLOWOUT PROTECTION!



Two layers of the cord fabric in these tires were deliberately cut through with a knife. Then a stunt driver raced the car off the ramp, landing with a crash 30 feet away. Not a tire blew—not an ounce of air was lost. Goodyear's exclusive 3-T Cord and Grip-Seal construction give you the most durable tire body ever made!

Goodyear's exclusive 3-T Cord and Grip-Seal construction make possible this ultra-modern tubeless tire!

No tire is blowout proof. Any tire may blow out if it is cut through or severely damaged.

But naturally the tire with the strongest cord offers the greatest protection against cuts and injuries that start fabric breaks—the most common cause of blowouts. 3-T Cord is so tough that breaks grow slowly. Instead of a sudden dangerous blowout, you get only a gradual loss of air.

In its exclusive and patented 3-T process, Goodyear triple tempers tough cord sinews and integrates them with improved rubber and Grip-Seal construction to produce a tubeless tire body that's completely airtight — the most durable ever made! Goodyear, Akron 16, Ohio.

More people ride on Goodyear tires than on any other kind!

TUBELESS DELUXE SUPER-CUSHION

by GOODYEAR

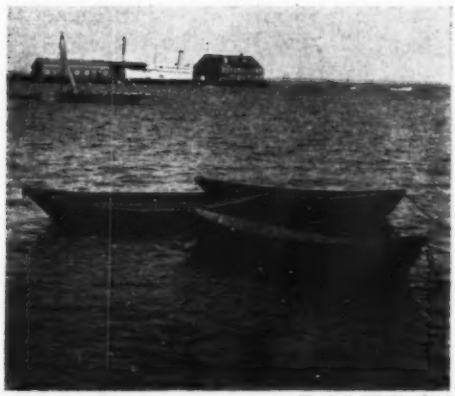
Super-Cushion, T.M.—The Goodyear Tire & Rubber Company, Akron, Ohio.

THE TECHNOLOGY REVIEW

TITLE REGISTERED, U. S. PATENT OFFICE

EDITED AT

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY



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Published monthly from November to July inclusive on the twenty-seventh of the month preceding the date of issue, at 60 cents a copy. Annual subscription, $4.00; Canadian and foreign subscription, $4.50. Published for the Alumni Association of the M.I.T.: Hugh S. Ferguson, President; H. E. Lobdell, Executive Vice-president; Richard S. Morse, Gilbert M. Roddy, Vice-presidents, Donald P. Severance, Secretary-Treasurer. Published at Hildreth Press, Inc., Bristol, Conn. Editorial Office, Room 1-281, Massachusetts Institute of Technology, Cambridge 39, Mass. Entered as second-class mail matter at the Post Office at Bristol, Conn. Copyrighted, 1955, by the Alumni Association of the Massachusetts Institute of Technology. Three weeks must be allowed to effect change of address, for which both old and new addresses should be given.

VOL. 57, NO. 5 **MARCH, 1955**

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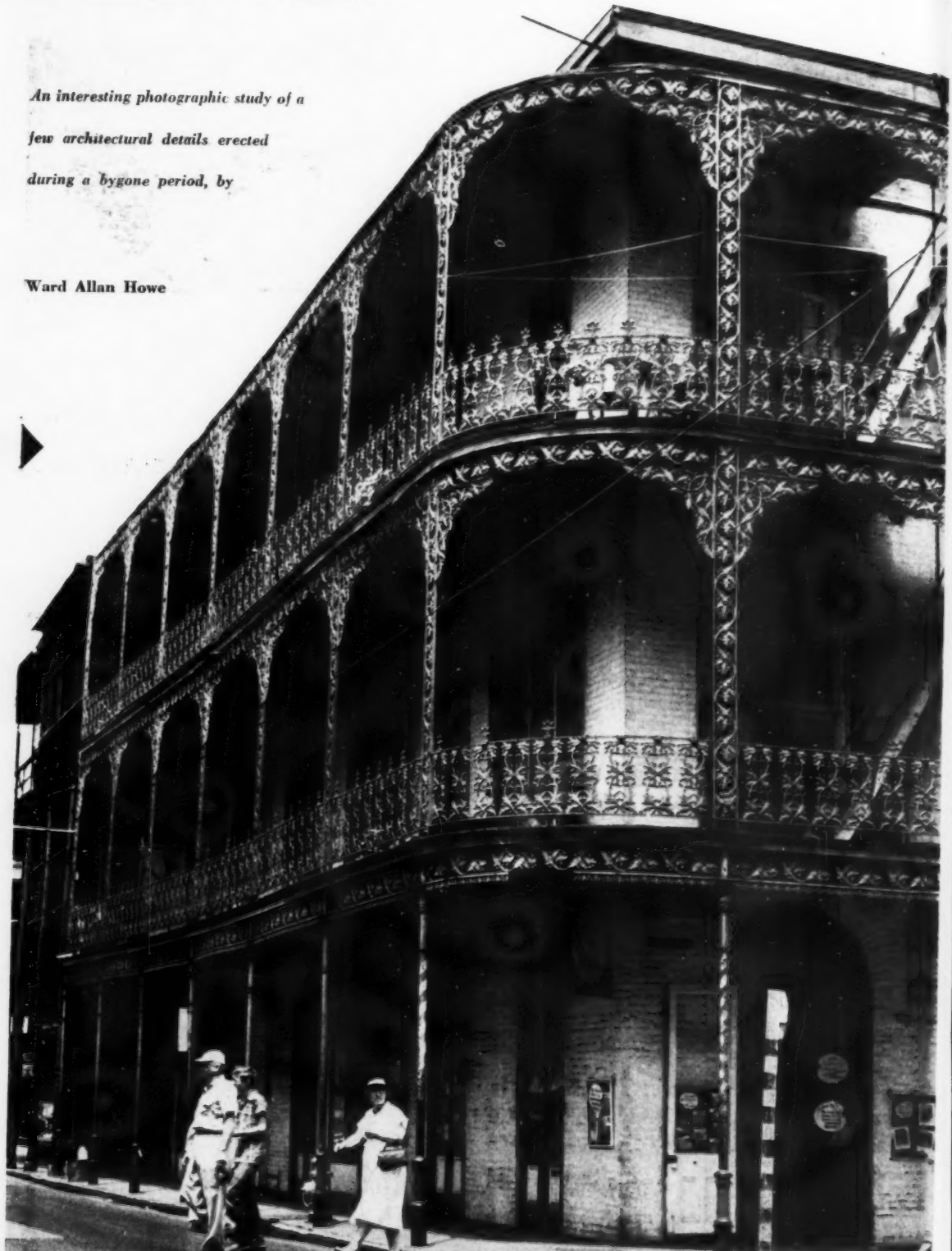


THE
TECHNOLOGY REVIEW

Vol. 57. No. 5 March, 1955

The Trend of Affairs

Soviet Technical Education

CONSIDERABLE attention has been drawn recently to the quantitative lead, over this country, which Soviet Russia now seems to have achieved in the education of scientists and engineers. Much less is known about the qualitative aspects of Soviet scientific education. In an attempt to evaluate these aspects, the Institute's rapidly growing Center for International Studies is conducting a pilot study of Russian higher education. The Center intends to examine in detail the educational process in at least one core science (physics) and one generalized engineering discipline (mechanical engineering). The work, begun several months ago, has recently been extended until the end of 1955 with the aid of a grant from the Carnegie Corporation of New York.

The notion of what is meant by quality in education is at best inexact and open to varying definitions in the hands of equally knowledgeable people. Certainly the capabilities of an educational system for turning out effective teachers, successful research workers, and competent industrial engineers are all relevant criteria. But the application of such general standards to an educational system, or to specific institutions within a system, in order to arrive at informed judgments is not easy. The task becomes considerably more difficult when the subject is technical education in Soviet Russia. Data are scarce and the language barrier is greater than it is for many other foreign countries. The Center's study, therefore, hinges on the development of satisfactory criteria for evaluating the quality of education and on the gathering of adequate amounts and kinds of information concerning the contemporary scene in Russian education.

The research to date has brought certain parts of the picture into reasonable focus. It is known, for example, that students entering any of Russia's 35 universities or its 180 higher technical institutes are equipped with a secondary school education that is uniform so far as curriculum is concerned for the entire country. Furthermore, this curriculum contains considerably more mathematics, physics, and chemistry than is given to students in America's pluralistic high school system. One implication of this fact is that Soviet institutions of higher learning do not need to devote their first year to making certain that students have reached a common standard in necessary core subjects.

Russia's higher educational institutions are considerably more specialized than is characteristic of this country. Only in the 35 universities, for example, can a student major in a pure science; science courses are offered in the 180 higher technical institutes, but only as service courses within curricula designed solely to turn out engineers. Thus engineering education (and presumably practice) is likely to suffer from the physical separation between it and scientific research, since the two activities are largely carried forward in separate institutions. In this country there has been a shift of the technical base of engineering from one that is largely empirical to one which is preponderantly scientific. The structure of Soviet higher education may not permit it to make such an adjustment effectively. If this is so, Russian engineers may suffer from a measure of inflexibility and lack of depth in their approach to the problems of their disciplines.

Another distinctive characteristic of Soviet higher education is the organization of the curriculum (typically a five-year course) into relatively narrow subjects of instruction and fields of concentration. We know, for instance, that men are trained not simply as mechanical engineers but as engineers in the technology of specific industries. Evidence at

hand shows that students specialize in such narrow subjects as "The Mechanical Equipment of Cement Industries" or "The Use of Machinery and Electricity in Animal Husbandry."

Such an engineering education might well be appropriate to the rapid expansion of existing Russian (or borrowed foreign) technology, but might be inadequate for creating technological advances or for producing engineers capable of moving among related industries. There is recent evidence to indicate that Soviet administrators have become concerned with the extreme narrowness of their higher technical education.

The Center's "Project Education" is being directed by Alexander G. Korol, who holds a master's degree from Columbia University and is a graduate of Columbia's Russian Institute. Mr. Korol was born in Russia and was in the midst of securing an engineering education when the revolution broke out. Mr. Korol and his small staff are assembling and analyzing materials such as textbooks, curricula, research papers, educational statistics, and so on. Several experts in the fields of science, engineering, and education are being invited to assist in the evaluation of these materials.

An informal advisory committee of senior professors in the Physics Department, consisting of Nathaniel H. Frank, '23, in charge of the Department; William P. Allis, '23, and Philip M. Morse, has agreed to help the Center's staff in establishing usable criteria of educational quality and in evaluating Soviet textbooks and the educational significance of Soviet facilities, curricula, and university practices. It is expected that a similar advisory committee will be formed among members of the Department of Mechanical Engineering. Several Faculty members in other departments also have expressed an interest in offering to help in their respective fields.

No published results of the study are expected before the end of 1955.

Tender Loving Care

PEDIATRICIANS supervising the welfare of foundlings in institutions, when a baby does not thrive although nothing seems to be wrong medically, are said sometimes to write on a child's chart the prescription "T.L.C.," meaning "tender loving care." In the absence of parents, this prescription is fulfilled by a volunteer or staff member, who spends periods giving full attention to the baby, playing with it, fondling it. Such treatment is held to benefit infants tangibly, in terms of improved physical growth and general well-being, when all of the objective expedients of medicine have failed. Skeptics, who may doubt that an imponderable such as "T.L.C." could possibly affect physically so insentient a being as a tiny infant, may be interested to learn of parallel observations made with laboratory animals.

Thus it has been clearly demonstrated that albino rats, of strains commonly used in laboratory research, attain greater maximum skeletal size and weight, and suffer less physical damage from a given amount of emotional stress, if they are taken from their cages and individually petted and played with, for as little as 10 minutes daily. These animals, and the unhandled rats with which they were compared, were given all the food they chose to consume. Superior growth and weight gain of the petted animals were due, it was found, not to the intake of more food, but rather to better assimilation of the food consumed.

Exposure of rats to stress, in the form of sudden loud noise, electric shocks or similar alarming stimulation, causes injuries to the cardiovascular system and the intestinal tract, that may be clearly seen at autopsy. Comparisons of unhandled rats, with rats which had been regularly petted, showed that a given amount and type of stress produced in the petted animals much less physical damage of the sort described. The petted animals apparently enjoyed a sense of security that helped them to react less violently to terrifying experiences. This phenomenon was thought to be attributable to relative physiological stability of the adrenal gland, in turn related to stable functioning of the nervous system.

Obviously, relationships such as those just summarized are easier to observe, and much easier to quantify, in laboratory animals than in human beings. Nevertheless, there is a published clinical study indicating that socioemotional disturbances measurably depressed the physical growth of children. Apparently a sense of security, based upon imponderables such as tender loving care, is physically beneficial to man and beast alike.

Sea Miles and Spheroids

ANNOUNCEMENT has been made via the National Bureau of Standards and the Department of Defense, that our nautical mile is now 6,076.10333 feet long. It had been 6080.20 feet. (The British, of course, continue with their own nautical mile of 6080.0 feet.) As far as practical navigation is concerned, the change is scarcely noticeable. To the science of geodesy, however, it recalls some interesting matters about the size and shape of the earth on which we live.

The intention, originally, had been to define the unit of distance for navigators (nautical mile) as 1/60th of a degree of latitude in length, and the meter as 1/10,000,000th of the distance from the equator to pole along the Paris meridian. This logical desire to tie the basic units of length to the girth of the earth by a pair of neat fractions has been subverted by the derivation, every several years, of a new and slightly different estimate of the size of the planet, and by the fact that even an idealized image of the earth is not a perfect sphere.

Eratosthenes (c. 276–194 B.C.) scored a remarkably close estimate of the earth's diameter as early as 220 B.C. (See The Review, January, 1955, page 133.) But general agreement about the size and shape of the earth did not occur until the Eighteenth Century. That the earth had the general shape of an oblate spheroid was demonstrated in 1736. Thereafter followed a series of measurements and calculations, still actively in progress, to determine the dimensions of this spheroid, in all possible detail. This ideal geometric shape, or geoid, which the geodesists use, as a matter of mathematical convenience, closely approximates the sea level surface of the globe.

In the United States, for example, much of the earlier triangulation and geodetic measurements were based on the Clarke Spheroid of 1866. But as measurements on the various continents accumulated, John F. Hayford of the United States proposed a spheroid which differed from the Clarke dimensions, in the fifth place. The Hayford data were adopted in 1924 by the International Union of Geodesy and Geophysics as the international ellipsoid of reference.

The so-called figure of the earth differs from the idealized geoid not merely in that mountains and land masses rise above the mean sea level surface, or that basins and occasional valleys drop below it. The actual mean sea level surface is a distorted figure of revolution, generally agreeing closely with the idealized spheroid, but sometimes being tilted in relation to it, or being at a different elevation. As far as the shape (but not the size) of the earth is concerned, measurements of the force of gravity permit rather precise determinations. In the last several decades, advances in instrumentation have resulted in portable gravimeters, and have even permitted measurements at sea, opening up some 70 per cent of the planet's surface to the exploration of gravitational anomalies.

A number of celestial methods for establishing the earth's dimensions are also being investigated. One depends on obtaining the exact moment of totality of an eclipse at three different points – two being on one continent, one on another. The points, of course, can be related to the triangulation nets of the countries involved. If the distance between the two points on one continent is thus known, it can be used to calculate the distance to the moon. This distance made known, some further trigonometry yields the distance from one of the two original points to the point on the other continent.

A rather similar system uses the occultation method, in which the times when a star disappears behind the moon's limb (the apparent edge of the moon's disk) and again emerges, are measured accurately at several stations.

A third technique uses a special camera to photograph, from different points, the moon and its surrounding stars distinctly enough to permit measurement of the angular distance between the moon's limb and the stars. With the aid of other data available, the distance of the observation points to the center of the earth can be obtained with an accuracy of about 40 to 50 meters.

Engineers as Businessmen

In recent years there has been an increasing awareness among economic historians of the importance of the personal factor in the process of economic growth. In particular, innovation and change in industry, at least in a free society, have come to be regarded less as responses to impersonal economic forces than as the product of a myriad of business decisions made by individual businessmen with complex motivations. In this process, technological considerations are necessarily a major element. Much of the study of innovation, for example, is concerned with technological development, and in the general area of industrial management it appears self-evident that a substantial proportion of the decisions that have to be made will involve technical problems.

The role of the engineer as technological expert is well known and easy to visualize. The relationship of the engineer to the managerial or entrepreneurial functions is less easy to discern, although it may be of fundamental importance in a technological society. Certainly engineers play important roles in the technical development of products and services. It is equally certain that no business can thrive unless such products or services are also placed on the market. The engineer must take part in this process; he may do this by making recommendations, for acceptance or rejection, of certain lines of action by those who make policy decisions, or he, himself, may be an active participant in the decision making processes of business.

The number of engineers who have become business leaders in the United States and the variety of industries and business organizations in which they have been active is substantial. Their success and contributions in fields for which they were not primarily trained raises a number of interesting questions. Is there any common denominator in the method by which they change from engineer to business manager? Why are engineers more prominent as entrepreneurs in some industries than in others? What characterizes the industries in which engineers are most influential? At what stage in the development of an industry are engineers most likely to be in control? Within the same industry are there significant differences between the firms which are managed by engineers and those which are not? In those industries in which research plays a significant part, may it not be desirable to employ engineers in managerial functions to a greater extent than in industries in which research plays a small part?

We are still a long way from being able to answer such questions. Nevertheless, some information on these topics is already available. Moreover, a program of research conducted by John B. Rae, Associate Professor of History, is under way to find answers to these and other related questions. In its initial stage, the program has been conducted with the assistance of grants from the Research Center in Entrepreneurial History at Harvard, and the School of Industrial Management at M.I.T.

Because of the magnitude of the subject, the study conducted by Professor Rae has so far been limited almost entirely to an examination of American industrial growth during the Nineteenth Century and the first decade of the Twentieth. It is not sufficiently complete to warrant definite conclusions, and certainly the important period of the past 40 years should be thoroughly examined before the study can be said to have achieved its aim. Nevertheless, on the basis of what has already been done, it is possible to suggest some general observations of a tentative character. These are offered more in the nature of hypotheses than as conclusions, and may be useful in indicating some of the main aspects of the main problem which appear to apply to all industries. They can be listed thus:

(1) Engineers have never constituted a majority of the business leaders in any industry. This point can not be elaborated further because there is insufficient quantitative data. But, the influence of engineers on business policy is not a function of their numbers.

(2) Engineers have been most conspicuous as leaders of business during the pioneering stages of industry, in situations where the basic problem was to make a new technological development commercially practical. The next most favorable stage seems to come after the industry has reached maturity and has attained a condition of relative stability.

(3) The industries in which innovation and technological change have been constant are most likely to have a strong engineering representation in management. This proposition may appear self-evident, but it is not clear whether the importance of the technological factor draws engineers into management, or whether the fact that engineers have an influential voice makes for a greater emphasis on technological change.

(4) For the period covered by the present study, engineers appear in general to have been more successful in becoming heads of small business concerns than of large ones. Of course numerous cases may be cited in which engineers – including a gratifying number of Technology Alumni – have reached top administrative posts in large corporations. Indeed, the increasing incidence of such cases in recent times suggests that the Twentieth Century has witnessed a very marked upward trend both in the proportion of engineers engaged in management and in the influence they have exercised on business policy. It is desirable that further study be undertaken to determine to what extent business practice with respect to the utilization of engineers in management has actually changed in American industrial development, and what the significance of such changes may be.

(5) The role of engineers in business has been determined in part by non-economic factors. Besides the obvious one of personality, questions of social structure and status need to be given weight. Some of the subordination of engineers in the textile industry undoubtedly traces back to the fact that the New England merchant-capitalists of the early Nineteenth Century had a tendency to classify all technicians as "mechanics" and therefore socially inferior, whereas the automobile industry, developing in a very different social climate, found it desirable to emphasize the contributions of its engineers.

The validity of these propositions may or may not be sustained by subsequent research. It is certainly desirable that they should be tested. If the issues that they raise can be resolved, then we will be able to make a reasonably accurate appraisal of the role of the engineer in the management of American business, and from that knowledge, to gain a clearer insight into the processes whereby technological change is integrated into industrial growth.

Machine Translation

EVER since the automatic digital computer was developed, there has been much discussion of the possibility of using these machines to perform tasks different from those for which they were designed. One of the possibilities that has intrigued many people has been the idea that perhaps such general-purpose computers could be programed to translate languages.

If it is possible to translate languages by machine, it seems that machines already exist that could do the job. The problem is to develop our scientific understanding of languages to the point where we know how to program such a machine to translate. The providing of such an understanding required for this purpose poses a great challenge to the linguist and to the scientist. The major problems to be solved are linguistic rather than mathematical or engineering.

Word-for-word substitution is certainly mechanically feasible. Various workers have shown that for related languages (as, for example, English, German, French, and Russian) a word-for-word substitution is of some use.

There are two great difficulties in word-for-word substitution as translation, however. The first one may be called the problem of multiple meanings; the second one may be called the word-order problem. They are actually aspects of the same problem.

The problem of multiple-meaning has sometimes been solved by submitting several alternative translations of each word. The reader is then asked to choose the best meaning from among the choices presented. Experiments have shown that it is, in general, possible but difficult for a person confronted with such lists of meanings to choose the best one.

Any strict word-for-word translation will have difficulty when the traditional word orders of the two languages involved are different. The relative importance of word choice and word order is different in different languages.

In a sentence-by-sentence translation, very few of the multiple-meaning and word-order difficulties remain. If a German scientific paper is cut up into pieces, each containing one sentence, these can be picked at random in arbitrary order and translated rather easily into English sentences, for example, with little loss of meaning. When the sentences are restored to their original order, a fairly good translation appears. It would seem, therefore, that sentence-for-sentence translation would be acceptable.

If sentence-for-sentence translation is to be done at all, then it seems that perhaps the only way is to take the word-for-word translation as a first approximation and improve on it by taking into account the context by a series of grammatical and syntactic rules. At M.I.T., research along this line is being carried forward between related languages in the Indo-European family (German into English), under the direction of Victor H. Yngve, Assistant Professor of Modern Languages, and the Research Laboratory of Electronics. The program is supported in part by the Signal Corps; the Office of Scientific Research, Air Research and Development Command; the Office of Naval Research; and the National Science Foundation. It is anticipated that it will be easier to solve the problem between these related languages, and it is hoped that such solutions will assist in the eventual solution of the more difficult problem of mechanical translation between unrelated languages – for example, Japanese and English.

The Limitations of Logic in Engineering Education

A Vertical System of Education, Emphasizing Simultaneous Development of the Logical and Informal Faculties Is Advocated

By JOHN B. WILBUR

Today's success in engineering education, and the promises of even greater significance tomorrow, can be a source of pride to engineering educators without being a basis for complacency. The suggestion of a new and different approach to engineering education, such as that contained in this article, inevitably implies some criticism of its present structure; yet it is the very strength of the present structure that merits the search for improvement. The views expressed here are personal ones of the author. They are presented with the hope that they may provoke interest and further discussion among the many who are constantly striving to improve engineering education. – Ed.

THE primary purpose of education is to aid young men and women in their preparation for effective living. The program of engineering education is built around a core of scientific and engineering subjects; it is desirable that this program aid in the development of good engineers, since engineering ability is an asset for effective living; it is, however, even more desirable that the program be directed toward preparation for effective living itself. Thus engineeering education can flower to its full potential only when it serves as a base for general as well as for professional development.

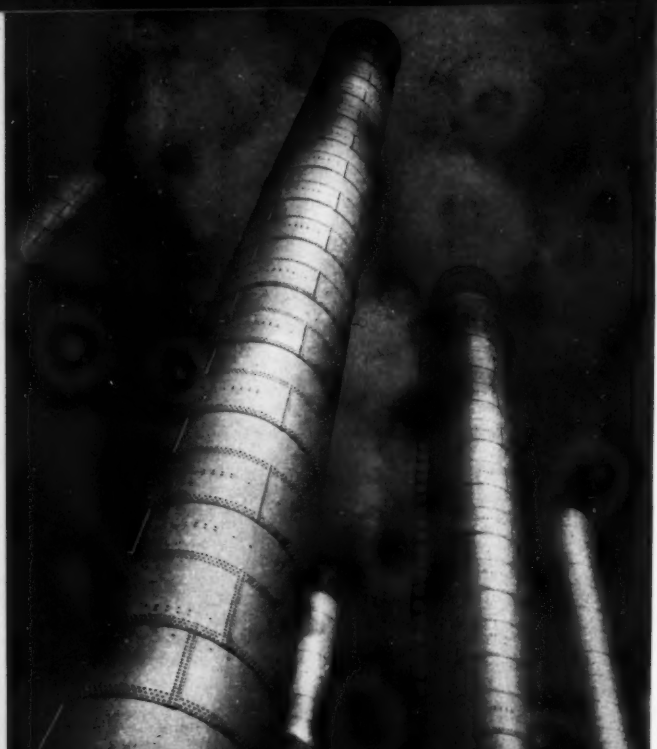
The Problem

The difficulty of attempting to cover, in any reasonable period of time such as four years, all the material that could be included to some apparent advantage in an engineering curriculum, is well known. In recent years, this dilemma has been heightened by the rapid growth of technology and by increased recognition of the importance of studies in the humanistic-social areas. A number of steps have been taken that aid in meeting this situation, and these include: a reduction of the time devoted to training in the manual skills and in the details of professional practices; a more efficient use of time through greater emphasis on the more generally applicable principles of science; and a tendency toward a lengthening of the period of formal education either through graduate study or, in some instances, by extending the duration of undergraduate education to five years. Yet the problem of the crowded curriculum is far from overcome; it is probable that we still crowd in too much coverage and, unless further means can be found to counter the effect of our ever-expanding technology, the difficulty promises to become more rather than less acute. Actually, such means are available and become apparent if we focus our attention on the proper objective of engineering education.

It is an obvious absurdity to attempt to teach so many things that the student will be prepared to meet most of the situations he will encounter – even in his professional life, to say nothing of his personal life; the effort should, rather, be largely directed toward the development of those qualities that will help him most in coping with whatever situations he may encounter. Thus while coverage of the curriculum is important, and deserving of careful consideration, it can – without serious detriment – be varied appreciably and restricted as necessary, provided the subject matter selected be taught so as to develop in the student those qualities that are most essential as preparation for an engineering career and for effective living.

What, then, are these qualities? With due humility, and without attempting to establish an order of importance, the writer ventures to consider them under the four categories of emotional, moral, physical, and mental. The emotional qualities would include those such as sympathy and kindness; the moral, those such as honesty and responsibility; the physical, those such as health and vitality; and the mental, those such as intelligence and imagination. While recognizing the full importance of the first three categories – the emotional, the moral, and the physical, they tend to lie outside the province of the strictly academic program, and will not, therefore, be discussed in much detail. They should certainly be integrated into the curriculum to some extent: Courses in the humanities can, for example, contribute to emotional maturity; the study of professional ethics, to moral growth; and required participation in athletic programs, to physical well-being.

There are also indirect ways in which the academic program can contribute to emotional, moral, and physical development: Happily, for example, engineering breeds honesty by its very nature; both science and engineering are importantly involved with truths that are inviolate, whence engineering education creates a climate that nurtures the moral condition that makes honesty almost instinctive. But it is the fourth category – that of the mental qualities – that is the essence of the academic program.



David W. Corson from A. Devaney, N.Y.

The educator in engineering, therefore, has the special obligation of utilizing engineering education as a vehicle for encouraging and helping his students to develop their mental faculties; in short – but not too accurately – the student should be taught how to think.

This conclusion will meet with little opposition; indeed, it is so close to being a cliché that some will wonder why the writer has labored to achieve the point. Most engineering teachers sincerely believe that engineering education, as we know it today, is extremely successful in teaching students how to think. It is true, of course, that we are very successful – possibly even too successful – in developing ability for one type of thinking – for logical thinking. But are there not other types of mental faculties that may be equally or even more important? The writer has been led to the conclusion that there are – that we are presently making too little deliberate effort to aid students in developing these other mental faculties – and that we should, therefore, modify our programs of engineering education along lines designed to achieve that objective.

The Analysis

Before defending the thesis that we are not, at present, properly developing the mental faculties of our students, it is necessary to give some consideration to the panorama of the mental processes. The writer does not pretend to fully understand these processes, or their interrelationships, or the way they operate as components of the so-called art of thinking; but he believes nevertheless that the distinctions made herein are sufficiently realistic to support the validity of the educational concept toward which this paper is directed.

For our purposes, we will consider these mental processes as being more or less separable into two major categories: the logical and the informal. Logical thinking is that somewhat formal, somewhat systematized portion of the mental processes that consists wholly or largely of *exact* reasoning. This type of thinking is so well understood and so highly esteemed by so many teachers of engineering, that it seems quite unnecessary to elaborate on it further or to extol its virtues. In order to make himself perfectly clear, the writer affirms his belief that logical thinking is essential, both to engineering and to effective living; the only qualification that he would and does make in this connection is that the ability to think logically should not be overdeveloped at the expense of the informal faculties.

The informal mental processes are those less formal, less systematized operations of the mind that involve relatively little if any *exact* reasoning. Unquestionably the logical and the informal faculties are more or less interwoven in most mental processes; some might, for example, say that judgment could be logical. A controversy on this point would be largely a matter of words and definitions: From the writer's viewpoint, and as used in this presentation, "judgment," if based entirely on exact reasoning, would be, not judgment, but logical thinking; it would, perhaps, be more accurate to say that logical judgment is informal thinking, largely supported by logical thinking. It is worth noting, too, that conclusions reached wholly or largely by use of the informal faculties, though not wholly supported by logic, are not in any sense necessarily illogical. It may simply mean that the logic that might have supported the conclusion is wholly or partly unused, or unknown, or, perhaps, nonexistent. It is well to remember that what we take to be some of our greatest truths are incapable, and will, perhaps, always be incapable of wholly logical explanations.

For our purposes, we will separate the informal mental processes into those that lead to values and those that lead to concepts: The first is represented by judgment, wherein reflection on past related experience leads to the formulation of values through comparison and discrimination; the second is represented by imagination, wherein some process of the mind leads to the formulation of mental images or concepts. Judgment and imagination may be either conscious and deliberate, and demanding of a certain period of time; or they may be largely subconscious and instinctive, and almost instantaneous in their action, from the conscious viewpoint – in which case we speak of them as being intuitive. Engineers, as a group, may be inclined to doubt the value of the intuitive powers; yet one may search a long time without success for the solution of a problem, and suddenly it will evolve – and perhaps at a time when he is thinking the least about it. It may well be, moreover, that the intuitive faculties appear in the creative processes to an important degree. In any event, we shall consider judgment, imagination, and intuition as major components of the informal mental processes.

In a discussion of creative engineering, Chester I. Barnard* wonders without casting any aspersions why it is that people who have had scientific training so frequently have so little sense, and concludes "that one of the important limitations of our civilization has been the overemphasis, the inclusive emphasis, of the importance of the logical processes and the sciences which have developed out of them, and exclusion of the appreciation of the other faculties."

The engineer and the scientist may question the validity of Barnard's observations and conclusions; yet if one considers a typical problem of life such as "How can I get Johnny to take more interest in his school work," or a typical problem of leadership such as "Whom shall I select to become the new division head," or a typical problem of engineering such as "What wind and ice loads should I use for the structural design of a certain television tower," it becomes necessary to acknowledge that one cannot get very far with the problems of engineering and of effective living if he must rely primarily on logic, and is either unable or unwilling to exercise the informal mental faculties. Logic implies a systematic relationship between all the factors in a situation; as expressed by Allan R. Cullimore, '07† it "does not in any way guarantee the ultimate solution of a problem" that is but partly systematized, or wholly "unsystematized and which, perhaps, has not been capable up to the present time of being systematized." Insistence on the almost exclusive use of logical thinking can lead to frustration, to misleading pseudo-logic, and to the avoidance of things that cannot be systematized; since such avoidance reduces participation in many of the activities encountered in life and in the broader phases of engineering, it is not too difficult to suspect why it is that some intelligent engineers are relegated to "turning the crank" so to speak, while other people who are less "intelligent" may determine the policies and issue the instructions.

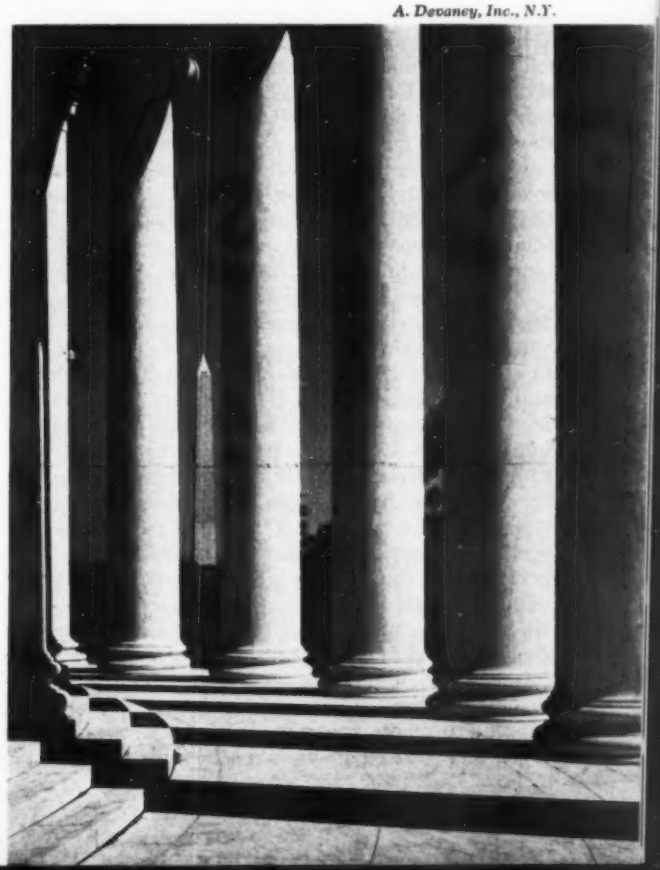
Thus while the ability to think logically is an important asset, logic finds one of its greatest uses in supporting the informal faculties; and the informal faculties themselves appear to be equally and possibly even more significant among the mental capacities. We cannot claim that engineering education is successful in teaching students how to think, unless it deliberately and effectively contributes to development of informal as well as the logical, faculties.

One reason why engineering education presently emphasizes the development of the logical faculties arises from the fact that it is easier to develop the relatively systematized processes of logical thinking than the essentially unsystematized processes of informal thinking. Some will question whether the informal faculties can be effectively developed or even developed at all by education. They may hold that these are things that cannot be taught; that potential good judgment, for example, is something that the student either has or does not have; that if he has potential good judgment, it can mature only by natural development extending over years of experience; that if he does not have it, nothing can be done about it. They may hold further that even if the informal faculties can be developed by education, the student – and particularly the entering student – is too immature, and too lacking in experience to be expected to exercise these faculties.

The writer agrees that judgment, as an example, cannot be developed in students who have little or no potential judgment, but holds that such students should not become engineers. If the successful pursuit of a course of studies required a certain degree of judgment, those students without potential judgment would fall by the wayside, and the mere process of academic attrition would upgrade, on the average, the judgment of our graduates. Now as for those students possessing potential judgment, it is true that they are immature and lacking in experience on which to reflect in pursuit of values; to the writer, however, this does not suggest that they are unable to use judgment, but only that their judgment may not be very good. It is, however, the *development* of judgment rather than the use of *good* judgment, that should typify the educational process; presumably the way to begin the development of good judgment is to start by using the best judgment one has – however poor it may be – and to hope that judgment will improve with use. If judgment is continuously exercised during the acquisition of a background of reflective experience, it should be possible to accelerate development of skill in the formulation of values by comparison and discrimination.

The alternate of not trying to use judgment to any important degree until the background of reflective experience has reached some arbitrary level is, to the

A. Devaney, Inc., N.Y.



* *Creative Engineering*, page 8 (New York: American Society of Mechanical Engineers, July, 1944).

† *Creative Engineering*, page 5.

contrary, certain to delay the development of judgment, and almost certain to exercise an inhibiting effect on its later development; it is worth-while pondering on the proposition that the entering student, with his native imagination and with his potential capacities for judgment and intuition, may well be – in some respects – in a more favorable position to begin the exercise of his informal faculties, than he will be after subjection over a substantial period of time to the climate of systematic thought, of exactitudes, and of definite solutions. Thus the student should be encouraged to exercise his informal faculties from the very beginning of his engineering education.

The difficulties of developing the informal faculties through engineering education are not, however, to be minimized; and this is partly because engineering education, as we know it today, creates a climate that presents obstacles to their most effective development. A major, though perhaps subtle, reason for this rather unfavorable climate, finds its source in the fact that engineering (the science and art of making economical use of the materials and forces of nature for the betterment and convenience of mankind) makes use of science (systematized knowledge considered in reference to the discovery of understanding of truth) and mathematics (the science of treating exact relations existing between quantities and operations) to such an extent that it is commonly believed necessary to introduce the student to the study of engineering through the study of science and mathematics.

While engineering, even in its elementary stages, is fertile with situations that present opportunities for developing the informal faculties, science and mathematics – to the student who is beginning his study of engineering – are essentially areas of logical thinking. Creative science and mathematics, and those areas of science and mathematics not as yet fully understood, may well demand as much use of the informal faculties as does engineering; but the engineering student, who studies science and mathematics as a prelude to engineering, does not rise to these scientific and mathematical heights. To him, science and mathematics represent a world of systematic exactitudes that leads him into engineering.

Thus the student, who comes to an engineering school eager to study engineering, is not permitted to study engineering at the time he is highly motivated to do so, but is made to study elementary science and mathematics – areas of study that do not easily lend themselves to the effective development of the informal faculties. The transition to engineering through mechanics does little, if anything, to improve this situation. By the time he reaches engineering itself – usually well along in the curriculum – the student is steeped in logic and almost totally inexperienced in the use of the informal faculties. What might have been an exciting adventure to a first-year student – an introduction to engineering involving the use and development of both the logical and the informal faculties – is now a somewhat disturbing experience; the student is entering a difficult period of readjustment; he wants to base everything on logic, and feels let down when he finds that he cannot do it; yet he somehow struggles over the hurdle, and begins to recognize the necessity, and finally the importance, of the informal faculties.

During his period of formal education, the student has been studying subjects in the humanistic-social areas; these areas afford excellent opportunities to develop the informal faculties; and the teacher of humanities has doubtless done his best to take advantage of these opportunities. But the latter has had his problems, too; altogether too many of his students have developed such a false set of values that they depreciate the worth of any subject that is not based largely on logic; and in his struggle to develop the informal faculties of his students, the teacher in humanities has, to a large extent, been forced to work alone. Though approving the goals of the humanities program, the teachers of science, mathematics, and engineering have unwittingly hindered rather than aided in their culmination.

If this rather depressing recital be somewhat overdrawn, it nevertheless has enough truth in it to warrant our serious disturbance. It seems almost unnecessary to conclude that engineering education as a whole struggles in a climate that falls short of an ideal setting for promoting the development of the informal faculties; that something should be done about it, even if that something involves a fairly major operation. Perhaps it is not amiss to add that if a major operation must be performed, this should not be totally unexpected; while there have been modifications and improvements in undergraduate engineering education during the years since its inception, its basic structure today is essentially the same as was introduced more than a century ago.

The Synthesis

If engineering education is to be an instrument for developing the informal as well as the logical faculties, the responsibilities for this must not be largely carried by default, so to speak, by our educators in the humanistic-social areas, but should be shared by our educators in the areas of science and mathematics, and even more so by our engineering educators. Briefly, the suggested approach to this goal rests on the proposal that an appreciable portion of the educational program should, from its very beginning, and extending throughout its entire duration, center on engineering assignments that cannot be carried out in their entirety on the basis of logical thinking, and are, therefore, demanding of the exercise of the informal faculties – problems of a type that do not have any one "correct" solution.

If we are to accept this proposal, we must – to an important degree – be willing to give up the *horizontal* concept of education which tends toward the addition of material – layer by layer – in a manner such that the material of each layer supports the material above it; in short, we should lessen our concern with the "prerequisite" aspect of the material to be taught. This is because the horizontal concept, in taking the student from the most generally applicable to the more specifically applicable areas of knowledge – as, for example, from physics to mechanics to structural theory to structural de-

(*Continued on page 256*)

A Bumper Crop of —

International Harvester Company

Grass

A Program of Grass Cultivation Is Urgently Needed to Permit Our Agriculture to Get Ready for Future Needs

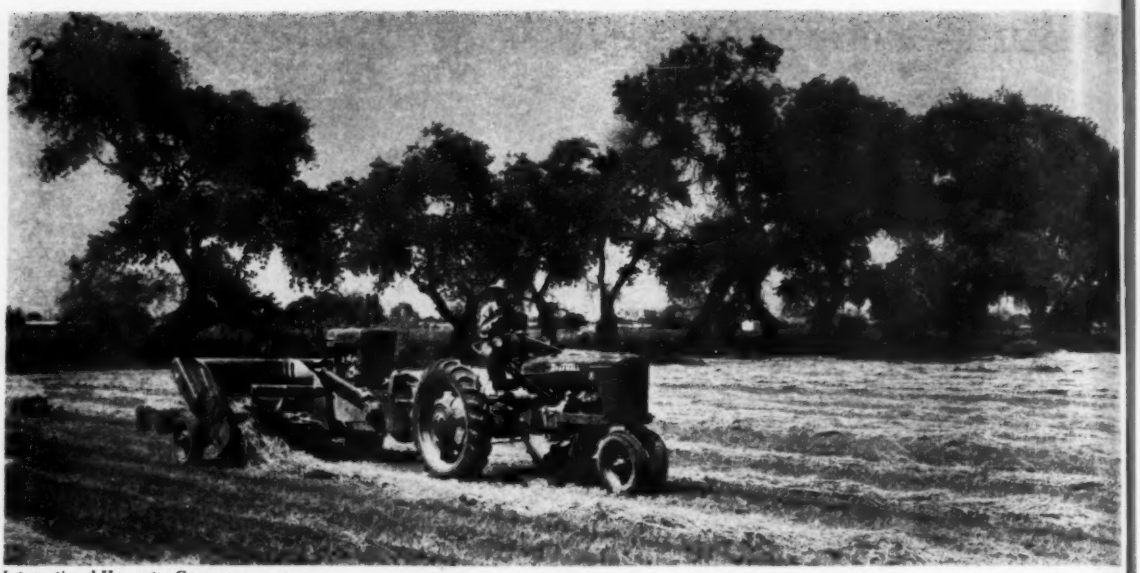
By MILTON E. PARKER

GRASS, suddenly, has come into its own! It soon may become a powerful economic force, influencing agriculture, government, and industry as few individual crops ever have before in our history. It is easily the most talked about topic in agriculture at the present time. Not only has it been debated at great length by the Congress, but it has also figured prominently in the deliberations of the President and his Cabinet, and is the keystone of a new national program developed by Ezra T. Benson, Secretary of Agriculture.

Thus American farmers who have broken all records in recent years with bumper harvests of corn, cotton, wheat, and other staples may well take to boasting of 1955 for its unprecedented production of yet another crop. And that crop, amazing as it may seem, will be grass – just plain old grass!

Such emphasis upon the sod types of grass rather than wheat, oats, and other food staples of the grass family will seem mysterious indeed to the average city dweller. For to him, grass is the contrary stuff he plants on his lawn in the fond hope that it will provide a lush green carpet to set off his home. Based on his experiences, he knows it requires watering – especially when urban water supplies are at low ebb due to drought conditions – or else it turns a heartbreaking brown color that definitely is not wanted. On the other hand, if Mother Nature sheds copious quantities of rain, he has difficulty getting it cut sufficiently often to keep it from looking like a pasture. Therefore, to the urban citizen, grass does not "produce" anything but a crop of headaches. Consequently he will be baffled to learn that it can be considered a "crop" by the wildest sort of reasoning. And to suggest that it might influence his future or his country's future, one way or the other, might seem mere piffle to him.

For farmers to be considering taking many millions of acres of land out of food production, in 1955, will probably convince many city dwellers that an end of farm prosperity is really in sight. Without knowing the facts, city folk may even assume that the farmer is in for hard times and that his troubles will doubtless spread to the industries supplying our agriculture. And if he is inclined to be panicky, his city cousin may fear that America's farm economy is tak-



International Harvester Company

ing a nose dive that inevitably will take the rest of the nation's economy along with it into another big depression.

Such fears are truly groundless. Actually they display a lack of knowledge about grass and the essential role it has played – and the still greater role it is expected to play – in the scheme of things. For, in reality, grass can be most beneficial to the nation.

Our farm output has been increased 52 per cent in the last decade to provide for present needs. Yet in the face of the knowledge that our population is increasing at a rate variously estimated of from 7,500 to 11,000 persons per day, there is every indication that production must be increased enormously to supply our future population. Greater production also means more mechanization, greater utilization as well as increased quantities of commercial fertilizer, plus vastly improved farm methods. It is even conceivable that millions of jobs will be created to supply farmers with the additional equipment and supplies they will certainly need.

With 70 per cent more children under five years of age than we had in 1940, our existing system must be nearly doubled in the near future. We probably will have to spend 40 billions of dollars just to meet current needs for schools and hospitals alone, besides providing jobs for thousands of bricklayers, plumbers, architects, engineers, chemists, real estate brokers, and others. Yet everything such groups buy for themselves will, in turn, help all of us. Factories must expand, highways must be modernized and expanded on a vast scale, and equipment must be replaced to cope with our expanding opportunities. In fact, our nation should spend the staggering sum of 500 billions of dollars immediately to meet our current needs for schools, hospitals, homes, highways, factories, and other basic necessities – according to The Advertising Council. All this is required solely for the tremendous job of keeping up with our future population growth.

With such gigantic tasks facing us, why is this the time for our farmers to raise a bumper crop of grass? The answer, briefed down to a few words, is simply this: *the program is needed to permit our agriculture to get ready for the future, while taking a necessary breather for the present.*

Basically, the current interest in grass is truly the harvest of legislative efforts to cope with the colossal surpluses of many farm crops. Most of our citizens are well aware that storage bins and improvised shelters are bulging with millions of bushels of grain, millions of bales of fibers, and millions of pounds of butter and other dairy products. While a comfortable surplus of farm produce is always good national security insurance against crop failures or the sudden demands of a great war, the present level of our storage stocks is realistically regarded as not only excessive, but actually dangerous to our nation's economy. Because of their Herculean size, our current surpluses are definitely exerting an unrelenting downward pressure on the prices of most commodities, despite the fact that the surpluses are being withheld from the domestic market. These surpluses have been stagnated because high price supports have made it all but impossible to market foodstuffs abroad in competition with foreign producers. This fact has become especially pertinent now that overseas farms are back in full-scale production, following the disruptions and upheavals created by World War II. To complicate the problems of the nation's economy still further, not only is the storage itself costing additional millions of dollars each year, but the problem of finding new storage space has become positively acute. Then, too, there is widespread danger of spoilage and waste, with John Q. Citizen facing the loss of many millions of the billions of dollars he has had to invest in food stockpiles of bumper crops in recent years.

To reduce further accumulations, drastic legislative measures have been enacted in an attempt to discourage the overplanting of crops already in surplus supply. For all farmers who participate in price-support programs, the acreage planted to surplus crops will be limited, as it has been in past produc-

tion control measures. For 1955, however, controls will also be extended both directly and indirectly to the farmer's "idle" acres – to make certain they will not be directed from one surplus crop only to be planted to another equally surplus one.

At this point, grass comes into the picture. From all present indications, millions of those idle acres will be planted to grass. Also, there is a strong possibility that millions of those acres, or their equivalents, will remain in grass for years to come. Despite the fact that the drastic program originally announced for 1955 has been relaxed, due to political pressures, the program as it now stands undoubtedly will force millions of acres into grass, due to stringent "cross compliance" requirements for crop supports.

To quote Allan B. Kline* who recently retired as president of the American Farm Bureau Federation: "We are . . . facing the fact that when 30 or 40 million acres are taken out of certain supported crops in order to hold up prices of those crops, it is unfair to allow production from the diverted acres to destroy the markets for the 60-odd per cent of the gross income of American farmers which comes from the production of unsupported crops."

In an obvious attempt to solve the surplus problems, such a program is a definite departure from anything attempted in the past. Yet it represents only a forward step for the farmer. Furthermore, it represents a step that properly should have been taken long ago. Augmented as it was by war demands and abetted by the subsequent peacetime price-support programs (based on acreage allotments), the intensified agriculture that has been practiced has come perilously close to exhausting much of our soil. Consequently, an enormous acreage of grasslands now can contribute immeasurably to a greater and more secure America for many years into the future. Furthermore, it will help prepare much of our land for the future demands to be made upon it by our constantly expanding population.

These seemingly startling beliefs are not without rhyme and reason, such as can be summed up in one brief statement, to wit; *agriculturists and economists are convinced more and more that grass is the most important crop the American farmer can grow at this time!*

Grasses are vitally important because they will prevent millions of "idle" acres from deteriorating. Such depletion of natural resources cannot be allowed to take place, for with the pressure of population as presently prevailing, it will only be a matter of time when many fallow acres of 1955 must go back into production. Until they are needed, however, they can form a living "reserve bank" of arable land – and each and every acre must be protected against Nature's ravages. The best possible protection is provided by grasses. The humble grasses that so nobly justify their existence as our defenses against erosion include the sod types and such members of the legume family as the clovers, lespedezas, alfalfas, and a host of similar familiar pasture plants. Grasses are a huge family which include the great food staples, such as wheat, rice, corn, sugar cane, sorghum, millet, barley, and oats – in addition to the pasture and lawn plants, such as Bermuda grass, bluegrass, rye grass, Johnson grass, and so on. In the grassland program, however, only the sod types, the legumes, and the pasture plants are generally considered.

The same characteristics that enable grasses to control soil erosion also make possible flood control. Grasses break the fall of raindrops, the litter acts as a sponge to absorb moisture, and the roots bind the particles together. Grasslands thus slow the runoff of rains and melting snows, permitting millions of gallons to percolate through the topsoil and into the underground supply that is an essential primary natural resource of the nation. Even underground water supply now is a matter of serious concern in many quarters of the land.† Because of overplanting of many soils to conventional crops, and primarily because of the inability of the watershed to absorb and retain moisture, in recent years disastrous floods have swept down many river valleys. Plain common sense, as well as good economics, requires the return of watershed areas to grasslands. This practice will improve flood control far cheaper than by the costly alternatives of the construction of dams, reservoirs, levees, and special drainage systems – all of which are, for the most part, symbols of the waste of good natural resources.

In addition to these advantages, grasses can also save thousands of acres of semiarid Western lands from "dust-bowl" destruction. For many years past, we have heard warnings that overgrazing and the cultivation of crops have been a threat to soil stability in the West. In the Great Plains that lie east of the Rockies, thousands of acres have been plowed and planted against the advice of soil experts. With the removal of the natural grass cover from these lands, winds already have removed millions of tons of topsoil, leaving the land barren of productivity and causing dust storms to sweep the nation. The retirement of these lands from crop cultivation, followed by seeding them once again with soil-holding grasses, will bring the awesome dust bowl under control, and may eventually heal its blight. Then, too, the resumption of cattle grazing (within the capacity of land) will again contribute to the prosperity of the now barren areas if the protecting grasses are given their opportunity.

Quite aside from these obvious advantages of grasslands, another is the "banking" of land it provides the thrifty farmer who plants only enough acres to satisfy actual market needs and holds in reserve, as grassland, the remainder of his land. Thus the farmer is the better enabled to regulate his production and, by working directly with the time-honored law of supply and demand, to a considerable degree he is able to control the prices he receives for his produce. Such practices will tend to stabilize farm income subject only to the variations upon crop yields imposed by weather. Of such hopes is composed the long-range objective of every progressive farmer. There is an even more important short-range advantage to the grassland program, however.

*Allan B. Kline, "A New Direction in National Farm Policy," *The Nation's Agriculture*, December, 1954.

†Thomas K. Sherwood, "Fresh Water from the Sea," The Technology Review, 57:15 (November, 1954)

We refer again to the fact that most farm lands have been in intense cultivation for years. This situation has dangerously depleted the content of organic matter within the soil. Organic matter is vital to soil tilth as well as to moisure-retention ability. Decaying organic matter also provides food for both microscopic and macroscopic soil organisms – from bacteria to earthworms – that help convert organic matter and mineral elements into readily utilized plant foods. It is the grasses that provide a greater supply of organic matter to the soil than any other crop. For as the sod blankets the field, the decay and consumption of organic matter is not interrupted as is the case when growing clean, cultivated crops, or when carrying out "pretty farming," as it is sometimes called. Then too, most grasses have a widespreading root system that penetrates and breaks up tightly packed clods to a soil with the crumb-like texture that means better land because it has "tilth."

Actually, land that is planted to grasses is not "idle" at all, for it is being improved in countless natural ways with the return of vital organic matter to the hungry earth. Thus the farmer who maintains a good balance of grasslands on his available acreage is drawing interest while thus "banking" his land in the form of increased land values and yields. By rotating his land planted to grass, soil productivity can be improved and sustained to the point where the farmer has prime land available to produce a bountiful yield of his "money crop" when he is ready to invest his "interest."

A still more immediate cash return can be realized if the farmer uses his grasslands not only to conserve and improve his soils, but also to raise a low-cost "crop" of beef or dairy cattle and other livestock for the national market. Not only do livestock return a substantial portion of plant nutrients to the soil in the form of manures, but the grass they consume is converted into meat, milk, mutton, wool, pork, poultry or eggs – commodities which the farmer can sell. At the present time, grass furnishes about half of all the feed consumed by livestock in this country, although it is authoritatively stated that between 75 and 80 per cent of all cattle feed could and should come from this source. Obviously, increased planting of grasses during the next few years can mean much to the cattle market, to the consumer, and to the farmer.

Bumper harvests have given America huge stores of foods and fibers. Yet it is hoped that a new farm program will reduce further accumulations. While most city-bred persons might assume that bumper crops mean continuing farm prosperity, actually, continued surpluses can mean just the opposite, for waste and spoilage always threaten stored foodstuffs. Grasses can serve America in many ways. Planted in watersheds, they can help control floods and prevent silt from ruining hydroelectric dams. They are also essential in controlling costly erosion along expensive highway roadbeds, for example. Then too, they offer the only hope for rehabilitating the vast dust-bowl area of the nation. Thus while many thousands of acres have already been damaged, grasses can prevent new and bigger dust storms. All-out production has depleted vital organic matter in millions of acres of land where grasses can improve soil tilth and give the farmer a golden opportunity to increase land values. Yet while rebuilding his soil, farmers can reap substantial profits from grass by raising cattle. This is a veritable example of "eating one's cake and hav-

(*Concluded on page 266*)

Carl Mansfield from Black Star

Interrupting the Great Conversation

Science Offers New Frontiers to be Explored as Well as the Virginal Beauty of a Poem Read for the First Time

By GEORGE TICHENOR

In the past several years there has been a marked decrease in the number of engineers and scientists who have been graduated from colleges in the United States, despite urgent national need for scientists and other technically trained personnel. The author's contention that an education in science and engineering can be just as cultural as one in the liberal arts – and definitely more practical as well, under present unsettled world-wide conditions – may not go unchallenged. Indeed, could an article on the education of young persons serve a more useful purpose than to provoke thoughtful discussion on this timely topic? – Ed.

THE time had come for our young one to go to college. He had always been interested in science and handy with tools, the engineering profession seemed to promise a decent livelihood, and right now, in this stage of the Cold War, our country seemed to be in crying need of scientists. So we were grateful to get him into M.I.T. From the cackle that went up from some relatives, and the neck-twisting silence of some friends, it was obvious we had committed a terrific blunder. Obviously, I hadn't realized that a liberal arts education is chic, and to have an interest in technical training is almost Fascist-minded. Furthermore, to send the boy to another school within tome's throw of Harvard – well, it was like condemning him to the salt mine within full view of Olympus.

Having had a liberal arts education, I am not impressed by its vapors uber vagaries; it is a relatively harmless adornment to a solid education if one has the time and the money for it in normal times. But these are not normal times. Few boys or their parents can afford to dribble out the years of preparation for a livelihood to age 25 or thereabouts. Moreover, intelligent citizens can hardly be complacent about the fact that, this year, the number of engineers graduated declined to a new low, at a time when the Soviet Union is turning out graduate engineers at the rate of better than two to our one, and with special inducements to young men to enter that profession. In these trying times, the humanists among our educators seem to intensify their efforts to crowd their elegancies into technical schools, at the expense, probably, of professional subjects crowded out of the curriculum, so that engineers are graduated with watered-down training. Belatedly, the public is awakening to the free world's need for more young scientists; but no outstanding educator is "sticking his neck out" to suggest the obvious: that we will not get the scientists we desperately need so long as vocal and influential groups, strongly backed by wealthy endowments, are beating the drum for Great Conversationalists.

Harvard is probably the best example of this Renaissance warmed over. *Time* magazine (March 1, 1954) devoted more than five pages to the University and its President, Nathan Marsh Pusey. Said *Time:*

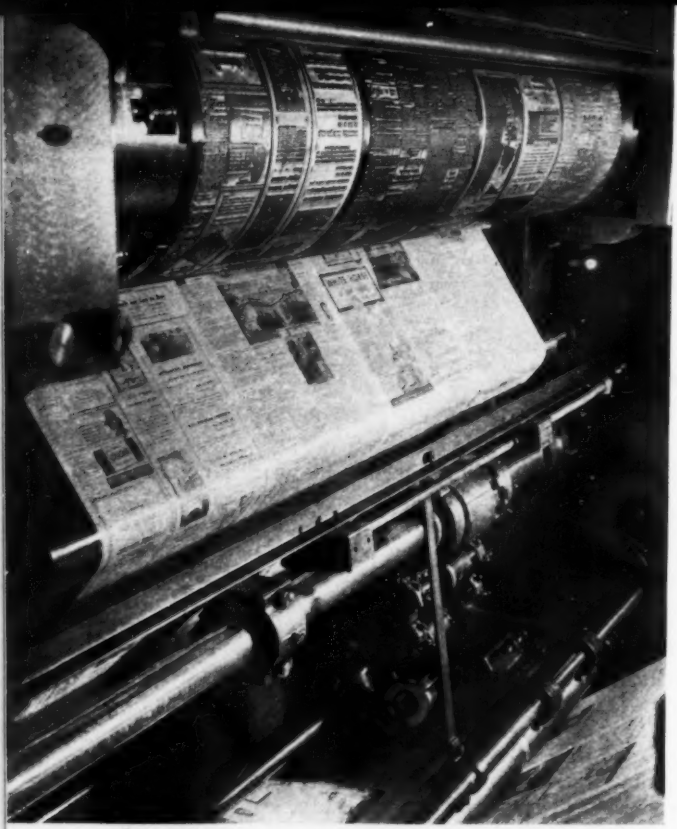
"On the undergraduate level, the pursuit [of knowledge] begins in the widest possible ways. When the curtain goes up it is to reveal the entire sweep of Western Civilization. With none of the old narrow surveys, students are required to take at least six broad general education courses, distributed throughout the humanities and the social and natural sciences. This amounts to a study of giant themes – e.g., the ideas of good v. evil in Western literature, freedom and authority in the modern world, the principles of science. From the start, students read Homer, St. Augustine, Dante and Tolstoy, study the great laws of science and the experiments and logic that produced them. Later, the stage narrows down to the student's chosen field."

Round and round about we go, avoiding the direct grappling with a subject – with Attila knocking at the door.

I can think of at least five reasons for recent declines in the ratio of graduates with engineering degrees to those with arts degrees. First of all is the present fad among educators to promote the Great Conversation. Harvard, already mentioned, is a potent bellwether. In the educational columns of the New York *Times*, almost any Sunday, are depressing quotations from college presidents more anxious to accept, than to buck, the trend.

Secondly, I suspect, there is a contagion of guilt-feeling among scientists for the way the world has gone since the first atom bomb was dropped on Hiroshima. Science is method; it is not a philosophy. But it is indicted as a philosophy – "materialistic science" – and resisted as such. As Bronowski points out in *The Common Sense of Science:** "Science is a way of describing reality; it is therefore limited by the limits of observation; and it asserts nothing which is outside observation. Anything else is not science; it

* Please see numbered references at end of article, page 264.



Ewing Galloway

is scholastics. The nineteenth century was dominated by Laplace's belief that everything can be described by its causes. But this is no less scholastic than the medieval belief, that everything is contained in the First Cause."[1]

Facing, day after day, the relatively less evil of odious choices, it is easy to see how scientists can develop a soft spot (as well as blind spot) for the sweeping Absolutes of doctrine – almost any doctrine. Unfortunately the Ages of Reason have been no less warlike than the others. Examine any one, such as, for example, that Golden Period of the Great Conversation, when Socrates and Plato walked together, and Pericles, in the sun-drenched glory of the gold and ivory monuments of Phidias, and the new, almost alabaster beauty of the Parthenon, could tell his fellow Athenians:

". . . ours is no workaday city only. No other provides so many recreations for the spirit – contests and sacrifices all the year round, and beauty in our public buildings to cheer the heart and delight the eye by day . . .

"Our military training too is different from our opponents'. The gates of our city are flung open to the world. We practice no periodical deportations, nor do we prevent our visitors from observing or discovering what an enemy might usefully apply to his own purposes. For our trust is not in the devices of material equipment, but in our own good spirits for battle.

"So too with education. They toil from early boyhood in the laborious pursuit after courage, while we, free to live and wander as we please, march out, nonetheless, to face the self-same dangers . . . Indeed, if we choose to face danger with an easy mind rather than after a rigorous training, and to trust rather in native manliness than in state-made courage, the advantage lies with us; for we are spared all the weariness of practicing for future hardships, and when we find ourselves among them we are as brave as our plodding rivals.

"We are lovers of beauty without extravagance and lovers of wisdom without unmanliness . . ."[2]

There was nothing to mar this most beautiful oration of history, except that it was made at a funeral and there were dead men at the feet of Pericles – with many more to come. Neither beauty, nor philosophy, nor lovely utterances stayed the Spartans, whose one specialty was war.

Third, and closely akin to the scientist's aversion toward products which his knowledge makes possible, is the average man's escapism into thoughts remote from today's happenings. The "timelessness" of the humanists is wonderful indeed. There is no time like the past. History, with its dragons in amber, is a satisfying pursuit for timid men, and the past has an imprinted security in these days of slippery footing. John R. Everett, President of Hollins College in Virginia, wrote:

"There is also a significant number of professors who have retreated into the past and now reside in uneasy poverty behind the barricades of what they call the 'scholarly tradition.' Students are admitted to the fortress for fifty minutes three times a week to hear a disorganized recitation of facts or a logical exercise in irrelevancy read from ancient notes. Since the professor is usually afraid or contemptuous of questions, the lectures end with the bell and a sincere sigh of relief all around."[3]

Fourth, is propaganda. The liberal arts crusaders are to be congratulated on the way they can separate the best of two worlds without breaking the yolk. Their program of lofty idealism is being marketed with the most shameless emotionalism. They have appropriated all the good words, in a way that must win the admiration of any sincere huckster. Note these emotion-loaded words and their effect. What is the opposite of, or other-than, "liberal arts"? Manifestly, it is the *ill*iberal, or reactionary, or scientific. If liberal arts has the Great Books, what do the scientists have? And what is the opposite of "humanist" studies? Patently, it must be *in*humanist, diabolical, alchemical, scientific. You can guess who is worthy to take part in the Great Conversation.

You can't grab by head or tail a statement like this one made by Dr. Pusey: "Not the scientific exploration of things, nor the scientific examination of the behavior of groups of people, but the living, vivid acquaintance with the adventures of the human spirit – this it is which especially can stretch the humanity that lies in man . . . and needle it into its fullest growth."[4] I don't know why it is assumed that the scientist must be a test-tube drudge and that Curie, Pasteur, Pythagoras, and the rest never experience those skin-stretching thrills to which aesthetes are addicted.

Dr. Pusey, I am sure, is no snob; there is, however, an aura of snobbishness about what used to be called a "gentleman's education" and this is almost in direct

ratio to its impracticableness. Veblen's theory of "conspicuous consumption" is flaringly evident here, and snobbishness is the most titillant ingredient of advertisements.

I have just received a letter from the Adult Education Association which begins: "Because of your own leadership roles, I have been authorized to transmit to you the enclosed invitation to associate membership . . ." Could anyone ring the bell more sweetly? I haven't the slightest idea what might be expected of me as a member – maybe I would have to sell the Great Books – but all I can think of at the moment is that for $5.00 I could get a listing in the A.E.A. Membership Directory – " a valuable tool enabling national and community leaders to familiarize themselves with other individuals in leadership roles." It also appears I would get the *Leaders' Digest*. It might be playing hard and fast with diabetes, but few of us can resist such sweets. I see myself, already, way up there on the dais.

The Adult Education Association is assisted by a grant from the Fund for Adult Education, an independent organization established by the Ford Foundation, of which Robert M. Hutchins is associate director. Dr. Hutchins, our fifth reason, is worth a full division in the onslaught on technical education. He is witty; he has a flair for making the news, whether in educational journals or *Sports Illustrated* (on why they banned football at the University of Chicago);[5] and worst of all, he is eminently fair-minded and liberal, so that the weight of his authority can be disastrous when he plunges into the areas where his blind spots are total. He cheerfully recognizes, even seems to foment *The Conflict in Education in a Democratic Society*,[6] title of one of his books. After a scrutiny of alarming statistics on the sinking level of the output of our technical schools, it is a dizzying experience to come to this book and hear Dr. Hutchins decrying the way technical education is encroaching on the liberal arts! His point may be understandable – if you happen to feel that a liberal arts course is not only the *summum bonum* but the only good of education.

"When I urge liberal education for all," says Dr. Hutchins, "I am not suggesting that all the people must become great philosophers, historians, scientists, or artists. I am saying that they should know how to read, write and figure and that they should understand the great philosophers, historians, scientists, and artists. This does not seem to me an unattainable goal."[7] This is indeed a task, if you do the job thoroughly and if you are also trying to learn a profession within a four-year college span.

But to prepare for a livelihood seems hardly a worth-while aim in going to college. Technical training of any sort is almost denigrated, it is equated with courses in cosmetology, and certainly hardly worth the serious attention of thoughtful men. For example, ". . . the emphasis on vocational training in America is poor mechanics without education . . . industrial operations have been simplified to the point where little or no training is required for them – they can in fact be performed by twelve-year-old children. . . ."[8] The whole doctrine of adjustment to the environment . . . leads to a curriculum of miscellaneous dead facts. It leads to vocational training, which the schools are not equipped to give . . ."[9] Certainly will be less equipped to give if Dr. Hutchins' supporters have their way.

"Meeting Immediate Needs" (Chapter II) gets a special spanking from Dr. Hutchins. The needs change, they distract attention from timeless values which are presumably more important that the problems of the day. This argument reminds me of a man stumbling ahead and falling from potholes into chasms – but his eye is fixed to a telescope. Dr. Hutchins gives the impression that he will oppose all *ad hoc* considerations until we are all post mortem.

Dr. Hutchins harks back wistfully to the medieval University of Paris, and to the age of speculative debate – which the age of discovery severely cramped with its rude emphasis on the undebatable fact. In the field of Twentieth Century education, the need to meet immediate needs has resulted in an "infinite incoherent proliferation of courses largely vocational in aim,"[10] says Dr. Hutchins, who adds "the ordinary American university presents an array of vocational schools of incredible variety and insignificance."[11] Also, "I do not wish to resort to the doctrine of guilt by association in lumping pragmatism, positivism, and Marxism together. But they have at least these characteristics in common, characteristics that are fatal to liberal education . . . They all repudiate the past. They all exaggerate the role of science and the scientific method, and appear to hold that the only way of obtaining valid knowledge is the way of experimental science."[12] Dr. Hutchins' own extremism is excusable in the fervor of his feelings, but it might bode ill for a technical school knocking at the door

G. A. Douglas from Gendreau, N.Y.

of Dr. Hutchins' study for a handout, without proper obeisance to the Greeks.

Here and there, he clobbers the specialist: "The process of specialization has therefore turned out to be a process of inhibition. The traditional definition of specialist is that he is a man who learns more and more about less and less. In the United States we have discovered that he can be a man who learns less and less about less and less."[13]

Let us turn now to the type of pedagogue Dr. Hutchins admires, who, if he will pardon the paraphrase, learns less and less about more and more. He is hurrying to a faculty meeting in the ideal university to discuss: "What is a good life? What is a good society? What is the nature and destiny of man? . . . These questions and others like them . . . not susceptible of scientific investigation . . ."[14] The liberally educated man should be able to continue the Great Conversation that began in the dawn of history."[15]

To take part in the Great Conversation requires communion, and "The task of bringing about communion . . . can be performed, if it can be performed at all, only through a common training, a common appreciation of the different kinds of knowledge and of the different methods and techniques appropriate to each, and a common continuous discussion on the Socratic model of those ideas which can pretend to be important, together with the consideration of the practical implications of those ideas."[16] Pity our peripatetic pedagogue if he happens to be a pariah who teaches science – though it's hard to imagine such in the ideal university. From what bootlegger will he get the learning, or when will he have time to imbibe it, when so much time is taken with the Esperanto of the humanists? At any rate, he had better not rise in the symposium with science on his breath!

And now we interrupt the Great Conversation to bring you an important bulletin . . . "While the democracies of the world, including the United States, are looking the other way, the Soviet Union and its satellites are training scientists and engineers at an almost feverish pace. The Soviet Union has set out on a definite state policy first to reach and then to outstrip the free world in the preparation of scientists and engineers essential for survival . . ." Thus recounts the New York *Times* on its front page (November 7, 1954), while inside, a full page survey by Benjamin Fine is devoted to an alarming educational trend in the United States. "Not many educators," writes Mr. Fine, "are aware of the tremendous Soviet spurt in the scientific fields. Despite the urgent need for additional engineers and other technically trained personnel in this country, the supply has gone down in the past four years. In 1950, the peak was reached when the nation's colleges graduated 50,000 engineers. This has dropped each year since then, going to a low of 20,000 last June.

"At the same time, the training of engineers and scientists in the Soviet Union has taken a directly opposite stand. In 1928, 11,000 engineers were graduated. By 1950, the number had jumped to 28,000. But in the last four years, the increase has been little short of phenomenal. The number of graduates rose to 40,000 in 1953 and to 54,000 this year. At the present time, the Soviet Union is graduating two and one-half times as many engineers each year as is the United States . . .

"According to Dr. John R. Dunning, atomic physicist and dean of the Columbia University School of Engineering, Soviet technical schools seem to be equal in quality to those of this country. Dr. Dunning said that the Soviet Union produced as many Ph.D.'s as the United States last year; however, while United States degrees were three to one in favor of the humanities, Soviet degrees ran three to one in favor of science and engineering. 'We have almost lost the battle for scientific manpower,' Dr. Dunning warned . . .

"Dean S. C. Hollister of the Cornell University College of Engineering, calls the situation . . . 'truly critical . . . Many persons fail to realize the impact that science, engineering and technology have had in our national life and world affairs. We can even note a desire that scientific and technological developments be curtailed. This would surely be the road to national suicide . . .'"

A certain presumptuousness of the liberal arts agitators is seldom openly questioned. Parents who were subjected to the liberal arts in their college days, simply shook themselves after the cultural sheep-dip and considered no great harm had been done; they shy away from the curricula of their children. Young men accept with too implicit faith the judgment of their elders, so that no professional group has such a free hand in dictating what the consumer shall get – and like – as the educators. Within their own intramural brawls, the liberal arts jingoists have the quips, they have the men, they have the money too. So "Foundations of Western Civilization" is becoming a "must" course in even the most ironbound technical schools.

It would seem, therefore, that we are turning out not only fewer engineers, but that today's engineering graduates are less prepared for their professional work than they were a decade or two ago. When the "ivory hunters" of General Electric Company and other corporations take the best of each year's crop of graduates, it is increasingly the practice to send the young men not into production, but into further study in integrated schools run by the companies, with courses continuing a year or two or longer. At least 35 corporations, says *Fortune*,[17] are operating these integrated schools and others are being set up. Investment per trainee goes as high as $10,000 a year, and averages $2,500. For all of this professional post-college training, you and I, our children, and our country ultimately pay.

The late John Dewey once remarked that there was one point on which the consumer is the world's outstanding authority – "where the shoe pinches" – which has emboldened me to make this complaint. In this country the cost of higher education, coupled with the lowering scholastic standards of, and the deficiency of adequately paid and properly qualified teachers in, public schools is cause for serious concern. The rejuvenation our educational system requires might well be directed, I feel, into the following channels.

(*Continued on page 260*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Democracy in Action

THIS spring Technology Alumni will, as usual each year, elect: officers of the Alumni Association of M.I.T.; alumni term members on the M.I.T. Corporation; members of the National Nominating Committee; and (for classes whose numerals end in one or six) class representatives on the Alumni Council. Ballots calling for the election of such officers will be put in the mails on March 25. Counting of ballots is scheduled to take place on April 25, and the results will be published in the June, 1955, issue of The Review.

Nominated to serve as president of the Alumni Association for the year beginning July 1, 1955, is Dwight C. Arnold, '27, XV, President and Treasurer of Arnold-Copeland Company, Inc. of South Boston. Additional biographical material regarding Mr. Arnold appears at the left of his photograph at the bottom of this page.

To assist Mr. Arnold, the National Nominating Committee has named John J. Wilson, '29, XV, to serve for two years as the Association's vice-president. Mr. Wilson is vice-president of the Minneapolis-Honeywell Regulator Company, and heads its Doelcam Division in Boston. He is also president and director of the National Instrument Corporation; director of the Minneapolis-Honeywell Regulator Company; director of the Imtra Corporation; and member of the Executive Committee, Associated Industries of Massachusetts. Mr. Wilson has been active in alumni affairs as a representative on the Alumni Council from 1950 to date; as Class Agent from 1951 to date; as a member of the Committee on Nominations for Departmental Visiting Committees, 1952–1955, and as chairman of that Committee for the current year; and as chairman of the 20th Reunion Committee of the Class of 1929. He is president of the Skating Club of Boston; and a member of the M.I.T. Faculty Club, the Corinthian Yacht Club, the St. Botolph Club, and the Minneapolis Club.

The National Nominating Committee (which presents names of candidates for nomination and election) has, as its members: Raymond H. Blanchard, '17, chairman, Saxton W. Fletcher, '18, Whitworth Ferguson, '22, William S. Brackett, '23, David J. Sullivan, '24, Roger W. Allen, '27, Richard L. Cheney, '27, Morgan Collins, '27, Robert J. Joyce, '28, and Albert R. Pierce, Jr., '31. This Committee has also nominated the following two members to serve, for two years, on the Executive Committee of the Alumni Association: Chenery Salmon, '26, XV, Vice-

Dwight C. Arnold, '27, XV . . . Nominated for Presidency of the Alumni Association

Fabian Bachrach

Presidential nominee for the Alumni Association of M.I.T. to serve for the year beginning July 1, 1955, is Dwight C. Arnold, '27, President and Treasurer of Arnold-Copeland Company, Inc., South Boston, and Director of Stevens-Arnold, Inc., also of South Boston. Mr. Arnold is corporator of the Home Savings Bank, and the South Boston Savings Bank. He has been unusually active in alumni affairs, particularly in the last decade. He was vice-president of the Alumni Association, 1952–1954; a member of the Executive Committee, 1947–1949; representative for his class on the Alumni Council, since 1936; member of the Alumni Fund Board 1951–1952; chairman of the Alumni Day Luncheon Committee, 1954; and previously a member of Alumni Day Banquet Committees. He served on the Committee on Honorary Members, 1946–1948; on the Committee for Financing Development, 1949–1950; and as member of the Committee on Student Activities since 1952.

Mr. Arnold is a member of the Brae Burn Country Club, having served as director, 1944–1950 and vice-president, 1950; of the 76 Club of Boston, of which he was president, 1945–1946; of the Boston Madison Square Garden Club, of which he is a member of the board of directors, 1955; the M.I.T. Faculty Club; the Newcomen Society; and the American Ordnance Association.

president of the Merchants National Bank of Boston; and D. Reid Weedon, Jr., '41, IX-B, Vice-president of Arthur D. Little, Inc., Cambridge.

Nominated to serve for five years, as alumni term members on the M.I.T. Corporation, are: Max L. Waterman, '13, II, Vice-president of the Singer Manufacturing Company, New York City; Fred C. Koch, '22, X-B, President, Wood River Oil and Refining Company, Inc., Wichita, Kansas; and Hugh S. Ferguson, '23, XV, President of Dewey and Almy Chemical Company, Division of W. R. Grace and Company, and President of the Alumni Association.

Nominations for representatives on the National Nominating Committee (with one Alumnus to be elected from each of the following districts) are: *District 1* – Boston – Horatio L. Bond, '23, XV; *District 2* – Manchester, N.H. – Robert C. Erb, '17, XV; – Portland, Maine – H. Stanley Weymouth, '19, I; *District 4* – Buffalo – Edward B. Germain, '13, II; Rochester – Dwight VandeVate, '22, X; Schenectady – Harold Chestnut, '39, VI-A; *District 5* – New York City – Irving D. Jakobson, '21, XIII; Newark – Clayton D. Grover, '22, V.

Boston Midwinter Meeting

WALKER MEMORIAL was the scene of the annual Midwinter Meeting for Alumni of Metropolitan Boston on February 3 – at which William E. Barbour, Jr., '33, President of Tracerlab, Inc., spoke on "The Versatile Radioisotope"; Davis R. Dewey, 2d, '41, Vice-president of High Voltage Engineering Corporation, discussed "Radiation Processing"; and William W. Garth, Jr., '36, President of Photon, Inc., presented thoughts on "A New Era in the Printing Industry."

Hugh S. Ferguson, '23, President of Dewey and Almy Chemical Company, Division of W. R. Grace and Company, and President of the Alumni Association for the current year, presided at this meeting which was attended by approximately 900 Alumni. Raymond Stevens, '17, Vice-president of Arthur D. Little, Inc., and a former President of the Alumni Association, was master of ceremonies, while Julius A. Stratton, '23, M.I.T. Vice-president and Provost, spoke as official representative of the Institute.

In bringing Boston Alumni up to date on recent events at the Institute, Dr. Stratton announced that ground will be broken this spring for a $3,000,000 laboratory building for education and research in nuclear science and electronics. The proposed laboratory building, which will comprise about 125,000 square feet of floor space, will be named as a memorial to the late Karl T. Compton, former President and Chairman of M.I.T. It will be designed especially for M.I.T.'s work in nuclear science, nuclear engineering, and electronics, together with related activities under the Departments of Physics, Electrical Engineering, and Chemical Engineering.

In conjunction with the new Compton Memorial laboratory building the Institute will also build a nuclear reactor to be devoted solely to education and nonsecret research in the peacetime applications of nuclear power. Speaking before an audience that filled Walker Memorial, Dr. Stratton said:

"If we continue making progress at the present rate, we are confident that we will have the capital funds this spring to start construction of the Karl Taylor Compton Laboratories.

"We shall continue with confidence to seek the additional capital funds necessary for the construction of the nuclear reactor and the supporting funds for the educational and research programs to be housed in these new facilities."

The 1955 M.I.T. Alumni Fund will be devoted exclusively to the Karl Compton Memorial.

"More than $275,000 has already been contributed to this year's fund," Mr. Ferguson told the meeting. "This sum," he added, "is already $40,000 ahead of last year's total which was the record M.I.T. fund year to date."

Other speakers introduced by Mr. Stevens, who was master of ceremonies, emphasized the way basic research develops new products and services.

Mr. Barbour, whose company applies radioactive materials to research and industrial purposes, gave a graphical presentation of the basic properties of radiation and radioactive isotopes. He demonstrated a typical use in the continuous measuring and control of thickness in various materials.

Mr. Garth, whose company has begun to install its newly developed Photon photographic typesetting machine, discussed the potential impact of this revolutionary method of composition on the printing industry. The machine's productivity, versatility, and simplicity of operation were demonstrated with the Photon equipment now being used by M.I.T.

Dr. Dewey, whose company manufactures high-voltage electrostatic generators, described a modern irradiation facility and discussed some of its applications in various manufacturing processes. He reviewed current applications in cold sterilization and the irradiation of plastic materials. Dr. Dewey also suggested possible future applications in food preservation and the promotion of chemical synthesis reactions.

Kresge Auditorium Opens

A RECEPTION and concert for members of the Institute's Faculty was held at the newly completed Kresge Auditorium on the evening of Thursday, February 10. President and Mrs. James R. Killian, Jr., were hosts on this occasion which provided members of the Faculty their first opportunity to inspect the new auditorium. Members of the Faculty had opportunity to meet Dr. and Mrs. James M. Faulkner, and Mr. and Mrs. Francis E. Wylie. Dr. Faulkner, Dean of the Boston University School of Medicine, has been appointed medical director at M.I.T. His appointment becomes effective in July. Mr. Wylie has been at the Institute since January 1 as director of public relations, as recorded in the December, 1954, issue of The Review.

Dedication ceremonies of the new Kresge Auditorium and Chapel will take place on Sunday, May 8. The Review plans to bring to its readers a report on these ceremonies, and to present in its June issue details concerning the architectural structure and intended use of these excellent new facilities.

Ivan J. Geiger: 1909-1955

IVAN J. GEIGER, Assistant Professor of Physical Education and Director of Athletics at M.I.T., died suddenly at his home in Newton on January 12. Professor Geiger came to M.I.T. as its first Director of Athletics in 1947 from the United States Coast Guard Academy at New London.

Professor Geiger was born in Bluffton, Ohio, and in 1932 received the degree of bachelor of arts from Bluffton College. The following year, after additional training in health and physical education, he was awarded the degree of bachelor of science at Ohio State University.

His coaching and physical education career began in the schools of Van Buren, Ohio, where in 1937 he was promoted to director of athletics and physical education. Professor Geiger entered the Coast Guard service in 1942 as lieutenant junior grade. In 1945 he was appointed executive officer of physical education and intramural athletics at the Coast Guard Academy – a post which he continued to hold after retiring in 1946 with the rank of lieutenant commander.

The author of numerous articles, he won national recognition within his profession for a three-year experimental program in coeducational physical education for upperclassmen in the Van Buren schools. He was a member of the College Physical Education Association and the National Association of Health, Physical Education and Recreation.

M.I.T. Photo

Ivan J. Geiger
Director of Athletics at M.I.T., 1947-1955

Automation Explanation

MOTION pictures on "M.I.T. Automatic Control Research" and an active discussion period on automation in industry provided the principal focus of interest of the 307th meeting of the Alumni Council. The dinner meeting, held on the evening of Monday, January 24, at the M.I.T. Faculty Club, was attended by 159 members and guests. Hugh S. Ferguson, '23, President, opened the Council meeting by introducing Godfrey L. Cabot, '81 (whose 94th birthday occurred on Saturday, February 26), Francis E. Wylie, recently appointed Director of Public Relations, and Walter Humphreys, '97, Honorary Member of the Alumni Council.

As Secretary of the Alumni Association, Donald P. Severance, '38, announced changes in class affiliation for seven Alumni. Programs for Regional Conferences in Dallas on January 29, and in Cleveland on February 26 were also announced. Fifteen members of the Institute's staff paid visits to 15 alumni clubs in the United States between November 3, 1954, and January 17, 1955. In addition, Professor Norman J. Padelford, of the Department of Economics and Social Science, visited the M.I.T. Club of Great Britain in London on December 6, Professor Paul M. Chalmers, Associate Director of Admissions, was in Havana on December 11, and H. E. Lobdell, '17, Executive Vice-president of the Alumni Association, paid one of his frequent visits to M.I.T. clubs in Monterrey and Mexico City on December 22 and 23. Also announced by the Secretary were nominations of the National Nominating Committee, as recorded in a separate item on page 245.

Frederick B. Grant, '39, chairman of the Midwinter Meeting Committee, reported that early returns indicated a large attendance for the February 3d meeting in Walker Memorial. (See report on page 246.)

Theodore T. Miller, '22, chairman of the Alumni Fund Board, reported that, as of January 24, the sum of $264,000 had been contributed by 6,790 Alumni. This amount, which will be devoted exclusively to the Karl Taylor Compton Laboratories, exceeds by $30,000 the final Alumni Fund contributions for last year, reached on June 30, 1954.

A letter received from Chang T. Chien, '22, President of the M.I.T. Club of Taiwan (Formosa), was read as indicating the appeal which the Compton Memorial Fund is making to Technology Alumni.

Gordon S. Brown, '31, Head of the Department of Electrical Engineering, was then called upon to relate steps in the production at the Institute of the film "M.I.T. Automatic Control Research" which was made by the Columbia Broadcasting System for its television program "The Search." The film showed a number of Technology staff members who described: (1) a demonstration model of a device built to move toward a source of light; (2) the Whirlwind computer; (3) equipment demonstrating the principle of feedback; and (4) milling machine controlled by prepunched tapes and associated computing devices. Dealing with the principles and potentialities of automation, the film ended with an informal scene in which James R. Killian, Jr., '26, President, made a statement that the adoption of automation in industry need produce no fears of social or economic upheaval if new automatically controlled devices are used understandingly and in a benign manner. President Killian warned that new kinds of automatic machines will require that students be trained with breadth of understanding of the social implications of the new instrumentalities of technology.

A question and answer period followed the showing of this film. Questions asked by members of the Alumni Council were answered by the four principals of the film: Professor Brown; Norbert Wiener, Professor of Mathematics; Jay W. Forrester, 6–45, Director of the Digital Computer Laboratory; and James O. McDonough, '43, Project Engineer, Numerical Control of Machine Tools.

"Double Major" Course

ESTABLISHMENT of a new type of double major course in which undergraduates at the Institute may combine studies in science or engineering with humanities and social sciences was announced in January by James R. Killian, Jr., '26, President. For the first time it will be possible for a student to obtain a bachelor of science degree from the Institute by qualifying in both liberal arts and technological fields. The new plan of study, known as Course XXI, will be open to freshmen entering M.I.T. next fall.

Students choosing the course will not only be required to take two years of calculus and two years of physics, as are all M.I.T. undergraduates, but will do advanced work in technological subjects and in the humanities and social sciences. They will have a wide choice of such varied electives as "The Bible," "The Nature of Poetry," "The Philosophy of Science," and "Public Finance."

The chief purpose of the course, according to John E. Burchard, '23, Dean of the School of Humanities and Social Studies, will be to provide broad preparation for graduate work in science, medicine, law, industry or other fields, or for nonprofessional careers starting immediately after graduation. The student can obtain a degree in four years or, if he chooses, can continue his work through a fifth year to achieve professional status with a second S.B. degree. By a sixth year of study he can qualify for the master of science degree.

The course will be given under the Department of Humanities, which is headed by Howard R. Bartlett, Professor of English and History, and will be directed by John M. Blum, Associate Professor of History. But although the classes will be in the School of Humanities and Social Studies, subjects will cut across various fields, combining the viewpoints of history, literature, economics, sociology, psychology, and other disciplines.

"There is no trend toward changing M.I.T. to a liberal arts university," Dean Burchard said. "The Institute will continue to emphasize science and engineering. Most of the undergraduates undoubtedly will continue to major in specialized subjects, preparing for specialized graduate study or for positions in laboratories and industries immediately after four years of schooling . . . we believe that the course will provide the preparation that is needed by every citizen for intelligent participation in the kind of world we live in today."

Dean Burchard said it has not been decided how many freshmen will be admitted to the course next fall or how many will be admitted in later years, but the first students will be limited to a relatively small group with proven ability to meet the rigorous demands of a double major.

Course XXI is the outgrowth of Faculty studies in the M.I.T. curriculum that have been going on for a number of years. In 1944 a new humanities program was inaugurated. In 1949 a Committee on General Education, headed by Thomas K. Sherwood, '24, Professor of Chemical Engineering, recommended extension of the humanities and social sciences program.

Course VI Curriculum Revised

A GRANT of $50,000 from the General Electric Educational and Charitable Fund to aid in a fundamental revision of undergraduate electrical engineering education at the Institute has been announced by C. Richard Soderberg, '20, Dean of the School of Engineering. The grant will aid Gordon S. Brown, '31, Head of the Department of Electrical Engineering, to develop stimulating new instructional methods, materials, and techniques based on new concepts of teaching electrical engineering. In announcing the grant Professor Soderberg said, in part:

The Institute's Department of Electrical Engineering has a long record as a pioneer in developing educational methods in its field. From its early beginning as an option in physics in 1882, it awarded the first degrees in electrical engineering in the country in 1885. It was established as a department in 1902. Revision of the curriculum now calls for a break with tradition in every instance in which methods based on the heritage of the past no longer keep pace with or anticipate fundamental advances in the progress of modern science and engineering. . . .

Dr. Brown is working on this revision with the conviction that during their educational period students should be constantly confronted with the problems of tomorrow as well as the problems of today. It will be his aim to establish a unique system of classroom and laboratory instruction. . . .

The grant from the General Electric Educational and Charitable Fund will make it possible to study a new synthesis of classroom and laboratory material, documentation of new material in the form of classroom notes and texts, the development of new techniques of laboratory instruction and the assembly of a teaching staff with exceptional qualifications for achieving the goals of the new curriculum.

Shipping News

ON May 20, 1954, five members of the Visiting Committee on the Department of Naval Architecture and Marine Engineering met with representatives of the Department and of the Institute's Administration.* The Committee was pleased to note that all recommendations contained in Visiting Committee reports of the last three years had been carried out with excellent results, and that a recent appropriation will enable the Department to obtain photoelastic analysis instruments, a strain indicator, and supplies for the Ship Structures Laboratory. Development of this laboratory will increase the Department's teaching facilities by means of laboratory experiments and will extend the Department's research program.

The Committee was greatly interested in the recent expansion of the XIII-A curricula to include a fifth option, Nuclear Propulsion. This option provoked considerable discussion in which James R.

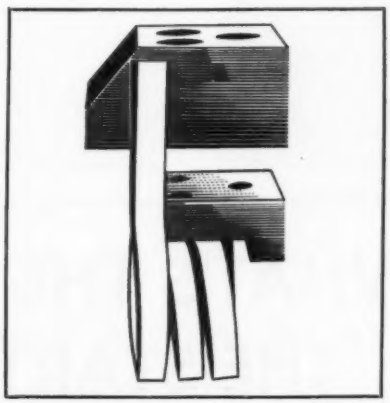
(*Continued on page 250*)

* Members of this Committee for 1953-1954 were: Robert C. Sprague, '23, chairman, Joseph V. Santry, '06, Irving W. Wilson, '11, Homer N. Wallin, '21, David A. Wright, '38, Thomas D. Cabot, Hollinshead de Luce, W. Durward Leggett, Jr., and Solon B. Turman.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

The assembly shown here is the actuating mechanism of an overload device, used to interrupt the current of electricity when it exceeds a certain value. Thus, it protects the apparatus connected to the lines with which it is associated. Naturally, the contacts are of copper, since copper has the highest electrical conductivity of any commercial metal. You will note the special forms of the two contact blocks. These are supplied to the manufacturer as extruded copper shapes, so that to make the contacts it is necessary only to cut pieces of the right length from the extrusion delivered by Revere, and drill the holes.



This method of slicing parts off a pre-formed shape can provide important economies by greatly reducing machining time. Take the bottom angular contact, for example. During development work this piece was milled from solid copper bar, dimensions 1 x 2 inches. The bar weighed 7.75 pounds per foot, and in machining it to the required form, 1.8 pounds of scrap per foot were generated. Copper scrap is readily salable at good prices, of course, but the chief expense in this operation was machining.

Once the design had proved itself under severe tests, Revere suggested copper shapes instead of plain bar. In the case of the angular contact, use of an extruded shape saved 1.75 pounds per foot, a reduction in weight sufficient to save almost 44 cents per foot over the plain bar. Larger savings were made by the reduction in machining time, and in the labor involved in handling scrap. Production also was speeded up. Though the shape cost more per pound than the bar, it made possible economies that much more than absorbed this.

• Another example, not illustrated here, has to do with an electronic device. The base plate must be non-magnetic, and brass was chosen. The design was rather simple, and one would not usually suppose that a special extruded shape would save money. However, to produce the part from solid bar, which weighed 1.61 pounds per foot, required three separate operations. The extruded shape weighs 1.22 pounds per foot, and its use reduces machining to a single operation. Result: a saving of 15 cents per part.

• These two examples are taken from the Revere files, which contain remarkable evidence of the economies that can be realized through extruded shapes. If your plant is doing any extensive machining of plain bar in copper and copper-base alloys, or aluminum alloys, look into extruded shapes. They can be furnished in much more complicated shapes than those illustrated, and can save important sums.

If you do not work with any of the Revere Metals, but with other materials, we suggest you get in touch with your suppliers and see if they may not be able to find ways to save you money. In buying, please remember that it is not the cost per pound or ton or gallon that is important, but the cost of the finished item. Sometimes paying a little more for materials may make the end product cost less.

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Killian, Jr., '26, President, and C. Richard Soderberg, '20, Dean of the School of Engineering, took a major part. In view of the Institute's plans to build on its campus an unclassified research nuclear reactor and the Department of the Navy's interest in the development of nuclear-powered submarines and large surface craft, in addition to the general interest of the commercial shipping industry, the Committee was of the unanimous opinion that a sound introductory course in Nuclear Physics should now be offered as an elective to graduate students, and that the building of such a reactor should be wholeheartedly supported.

Another matter considered by the Committee was the recent establishment of the degree, master of science in Shipping and Shipbuilding Management, to be awarded to students satisfactorily completing the five-year Course XIII-B. With the establishment of this new curriculum, Course XIII-C, Marine Transportation, which has been suspended for some years, will definitely be discontinued.

After consideration of the competence prospective students would acquire in the areas of management, administration, and economics, in addition to the technical competence acquired by the bachelor of science degree in Course XIII, the Committee thoroughly discussed the difference in emphasis between the former Course XIII-C and the new Course XIII-B. The Committee agreed unanimously that the new course would be of the greatest value to students, if the management and economics courses were specifically related, in so far as practical, to the shipping and shipbuilding industries.

The Committee's report was submitted to the Corporation at its meeting on June 11, was reviewed by the Executive Committee on September 17, and was released for publication in The Review on September 29, 1954.

Metallurgical Programs

THE Visiting Committee on the Department of Metallurgy* met on March 2, 1954, in the Given Room with Professor John Chipman, Head of the Department, and other members of the Department. Members of the Administration joined the group at the luncheon and afternoon meeting with Dr. Chipman. The report of the Visiting Committee, reviewed at the June 11 meeting of the M.I.T. Corporation and the September 17 meeting of the Executive Committee, was received for publication in The Review on September 29, 1954.

The first part of the morning session was given over to descriptions and discussions of the under-

(*Continued on page 252*)

* Members of this Committee for 1953-1954 were: Edwin D. Ryer, '20, chairman, Irving W. Wilson, '11, Howard H. McClintic, Jr., '19, Edwin D. Martin, '22, Cyril S. Smith, '26, Charles R. Cox, Isaac Harter, and Kenneth D. Mann.

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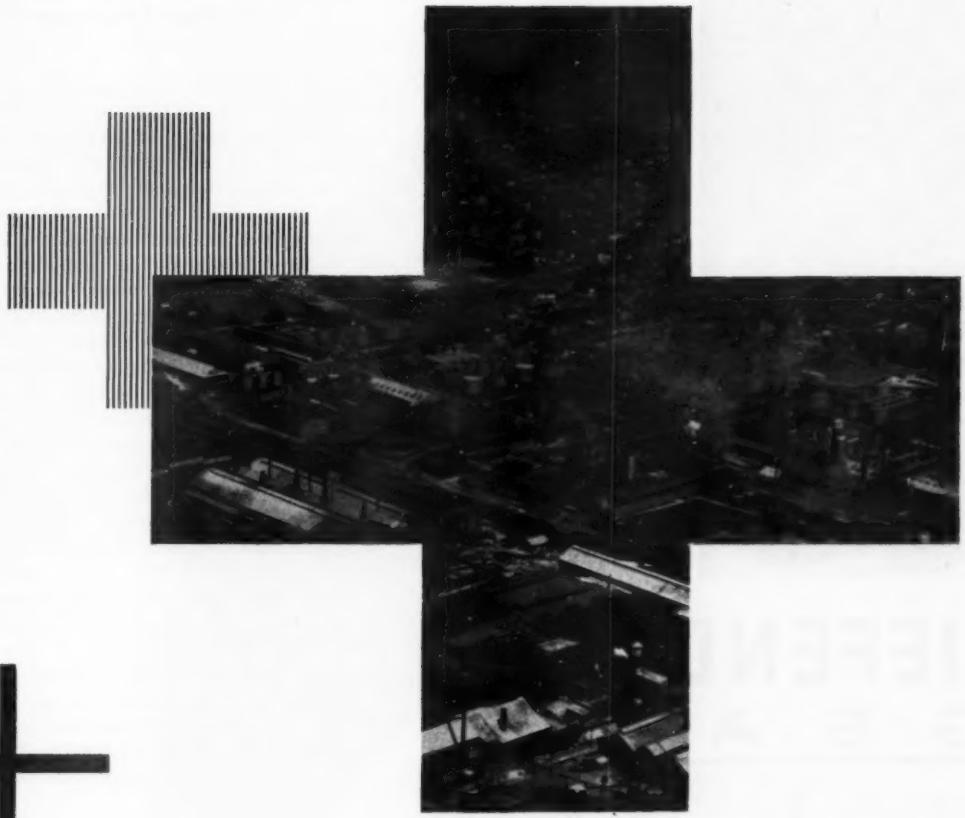

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THE INSTITUTE GAZETTE

(Continued from page 250)

graduate, graduate, and research programs. It was the impression of the Committee that these programs were adequate from the standpoint of content and were excellently administered. There appears to be a good balance between graduate training and research, which the Committee feels are mutually dependent on one another, and which should stimulate the undergraduates through contact with successful graduate and research work and workers. In connection with the research program it was pleasing to find that an increasing proportion of the work was being sponsored by industry rather than by government and that a large number of smaller projects are being carried out rather than a few large programs. This appears to be a very healthy condition. One of the Committee members called attention to the importance of further fundamental research in the field of brittle fracture in ferrous metals. A sponsored program in this field would be most desirable. The Committee felt that careful thought should be given to ways and means of interesting potential users of sponsored research in the facilities available in the Department and stressed the importance of dignified publicity in this respect.

An excellent presentation of the opportunities in Metallurgy was made to the students at the Institute

(Concluded on page 254)

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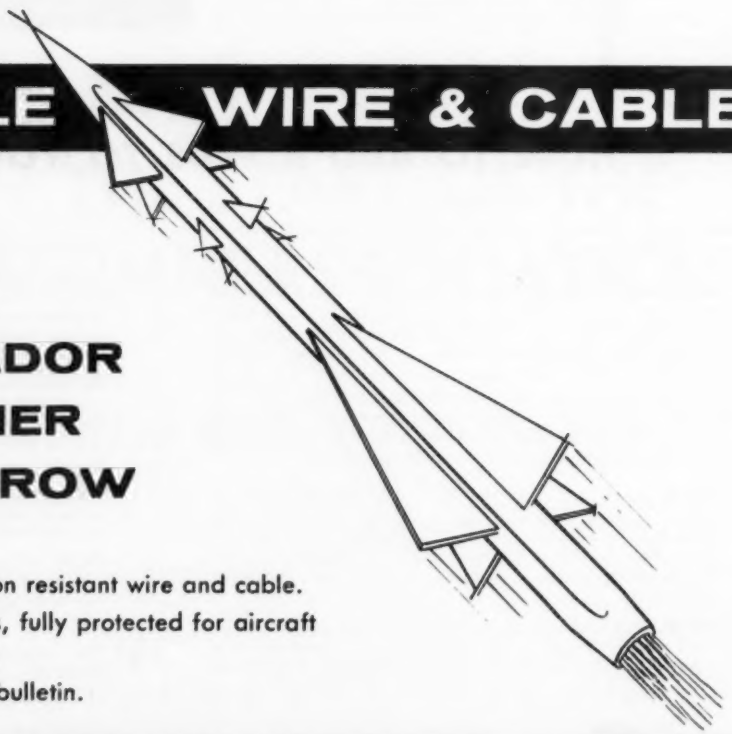

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THE INSTITUTE GAZETTE

(*Concluded from page 252*)

through the very fine exhibition arranged by the Department in the main lobby in February, 1954. It seems certain that such demonstrations would do much to interest students in a metallurgical career. It was the consensus of opinion that efforts should be made to further familiarize science teachers in secondary schools with the field of metallurgy as a means of attracting students.

The Department laboratories, in general, were reported to be adequately equipped, the one exception being the Metals Processing Laboratory where a few additional pieces of equipment would be desirable. The staff has succeeded in obtaining much equipment from industry and it is suggested that the Institute give serious consideration to the purchase of the needed additional items which do not appear to be otherwise available.

The Metals Processing Building is still without the passenger elevator included in the original plans and this appears to be a real handicap to the students and staff using this building. It was also noted that air conditioning in the large lecture room would be very desirable. It is suggested that these requirements be reviewed by the Administration of the Institute. The continued growth of the Department, particularly in the fields of graduate work and research, indicates that additional areas should be assigned for these purposes so that it will not be necessary to work under cramped conditions which to some extent now prevail.

As a result of a general discussion it was agreed that, in the general curriculum of the Department, emphasis should be placed on the science of metallurgy rather than on the engineering and practical aspects, as the graduate could more easily obtain experience in the latter while employed in this field.

The Committee was impressed by the enthusiasm of the staff and their very real interest in all of the problems of the Department. There was much evidence of co-operation among the members. While there are not many of the senior staff members nearing the retirement age, years pass rapidly and the Committee feels that it is important to bring into the Department young men who will grow to the same stature as those now occuping the key positions in the Department.

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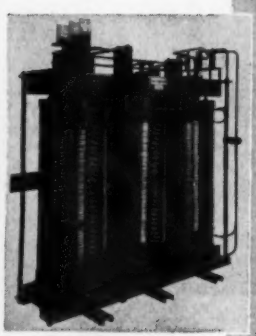

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LIMITATIONS OF LOGIC

(*Continued from page 236*)

sign – involves a progression from those areas where the development of the informal faculties is difficult and requires rather extreme measures, to those areas that involve art as well as science and which, therefore, are admirably suited to such development.

We should, instead, adopt a *vertical* concept of engineering education which, without primary concern over the "prerequisite" character of the treatment of material, tends toward the simultaneous development and constant interchange of both the logical and the informal faculties. We should – to oversimplify – establish a number of vertical stems such, for example, as science (including mathematics), engineering science (mechanics), engineering (design), engineering management, and humanities; and these stems should, in general, start at the beginning of the first year and extend during the entire four years; these vertical stems would be chosen not only for the importance of their subject content, but with particular reference to their suitability as vehicles for developing the total process of thinking.

If the vertical concept of education were adopted, it would give us an instrument that was capable of being used to develop the informal as well as the logical faculties of our students; the extent, however, to which it actually produced that development, would still depend on how the instrument was used – on the quality and type of teaching.

In a sense, the only true education is self-education; and we should remember this – not only because of its importance to formal education, but with a view toward the continuing education of the student after graduation; one of our objectives should be that of developing his ability and desire to continue with learning as a habit of living. Thus, while the instructor should guide and inspire, the student should be given the opportunity to work on his own, to discover for himself, to examine and develop his own ideas. More time should be available for the student to discuss his work and his ideas with his instructors, for student participation in classroom work, and for group or class discussions of subject matter and student solutions. If this type of teaching requires a drastic reduction in formal coverage, let us accept it; for to what purpose is the acquaintance with things unless a man has the understanding to profit from it?

As a possible example of an elementary educational experience designed to develop the informal as well as the logical faculties, let us suppose (for the purpose of general illustration only, and not as a basis for detailed criticism) that a relatively small group of first-year civil engineering students – say 15 – were given similar topographic maps showing a strip of highway with an obviously poor location, and were required, with a minimum of preliminary instruction, to work out a new location of the highway between two specified limits. The problem would be worked out in the drafting room with an instructor present who, however, would serve only to engage the students in provocative personal discussions as seemed desirable, and would restrain himself from showing

(*Continued on page 258*)

THE TECHNOLOGY LOAN FUND BOARD

Report for the Year 1954

For the sixth calendar year since the war, new loans made exceeded repayments on outstanding notes, these totals being $321,505 and $111,038, respectively. By the end of December, 1954, 2,700 individuals – or 69% of the 4,226 receiving loans since the Fund was established in 1930 – had completely discharged their financial indebtedness to it. The data presented below summarize the Loan Board's transactions during 1954 together with cumulative figures for the past 22 years.

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D. L. Rhind, *Secretary*
H. E. Lobdell, *Chairman*

Cambridge
March 1, 1955

CUMULATIVE RECORD OF THE TECHNOLOGY LOAN FUND TO DECEMBER 31, 1954

	At December 31, 1954	*At December 31, 1953*	*Net Changes during 1953–1954*
ITEMS OF OUTGO:			
Number of Men Receiving Loans	4,226	3,976	up 250
Total Amount Loaned	$3,245,518	$2,924,013	up $321,505
Average per Capita Loan	$ 768	$ 735	up $ 33
ITEMS OF INCOME:			
Number of Men Whose Indebtedness has been Completely Discharged	2,700	2,591	up 109
Principal Repayments in Advance	$ 686,192	$ 660,908	up $ 25,284
Other Principal Repayments	$1,462.466	$1.376.712	up $ 85,754
TOTAL PRINCIPAL REPAYMENTS	$2,148,658	$2,037,620	up $111,038
Total Principal Matured, Considering "Advanced Repayments" as Matured When Paid	$2,185,684	$2,071,978	up $113,706
Collection Ratio, i.e. Percentage of Total Maturities Paid	98.3	98.3	—
Matured Principal in Arrears	$ 27,400	$ 24,782	up $ 2,618
Actual "Written Off" Accounts	$ 9,627	$ 9,577	up $ 50
TOTAL MATURITIES UNPAID	$ 37,027	$ 34,359	up $ 2,668
Percentage "Written Off" to Total Loans	0.29	0.33	down 0.04
Percentage Matured Loans in Arrears plus Amount "Written Off" to Total Loans	1.14	1.17	down 0.03
Interest Received	$ 259,791	$ 250,379	up $ 9,412
Times Interest Received to Matured Loans in Arrears plus Amount "Written Off"	7.0	7.3	down 0.3
NOTES OUTSTANDING	$1,087,234	$ 876,816	up $210,418

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LIMITATIONS OF LOGIC

(*Continued from page 256*)

how and why things should be done. Each student would work out the best solution of which he was capable, using judgment, imagination, and intuition as his most important creative faculties, but supporting them by logic (including science and mathematical analysis) to the extent that he could.

At some later time – the next exercise, perhaps – each student would present and defend his solution, and there would be discussion of the merits and the weaknesses of the various solutions, together with some mention of those areas of knowledge that might have contributed to better solutions – given direction, as necessary, by the instructor, but carried out principally by the students. There would be no special emphasis on any one "correct" solution, such, perhaps, as might have been worked out previously by the instructor himself. It should be noted that the limited knowledge of the first-year student makes it easier rather than more difficult to devise problems which, for him, require the use of the informal faculties. With the increasing maturity and scientific proficiency of the student, the engineering problems would progressively depend less on art and more on science – but they would always include at least one or more elements that demanded the use of the informal faculties.

For years, it has been generally believed that, since engineering includes applications of science and mathematics, it is necessary that substantial education in science and mathematics precede education in engineering proper. The adoption of a vertical system of engineering education implies some reversal of this viewpoint, since it would involve, to some extent, the introduction to science through art, rather than to art through science. Such an inversion seems to have much in its favor, quite aside from its aid to the promotion of the informal faculties: It recognizes the principle that in education, as in any process using the mental faculties, one should acquire an approximate concept of the total before he attempts to fully understand its parts. For the student beginning his engineering education, this is extremely important; if it were recognized as a principle of engineering education, it would lend perspective and interest to the further study of engineering; it would develop motivation and balance for the study of science and mathematics; and it would, at the same time, encourage the student to think in

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the broader spheres of function, economics, and social impact as he approached engineering problems – thus pointing up the fact that portions of the humanities are not a thing apart from engineering but, indeed, part and parcel of the total problem. These supplementary advantages derived from art as a springboard to science suggest that a strong case can be made for broadening the base of the engineering stem during the first year.

Lest there be some who leap to the conclusion that the proposed approach to engineering education would be but a retrogression to vocational training, the writer insists that this is not the case – that, at least, it will not be the case if the introduction to engineering is properly taught. The art would not be introduced for its own sake, but it would be used as the most effective instrument for developing the informal faculties, for lending perspective to the further study of engineering, for developing motivation for the study of science, and for creating a favorable climate for the study of the humanities.

The relative merits of the vertical system of engineering education as compared with the horizontal, may vary somewhat within the total scope of engineering. The writer has been primarily concerned with civil engineering, in which he believes the development of the informal faculties to be both promising in terms of educational feasibility, and important to the needs of professional practice. While the feasibility of the proposed approach, if applied to education in the other branches of engineering, can be best appraised by others, it would appear that both the importance of the informal faculties, and, therefore, the limitations of logic by itself, pertain to the entire engineering profession.

Behind this whole presentation, there is a plea for a re-examination of certain of our educational values. There is the direct invitation to weigh the relative importance of logic as compared with judgment, imagination, and intuition. There is a request that the merits of the horizontal concept of education – based on the prerequisites of knowledge, be balanced against those of the vertical concept – based on the co-requisites of mental development. But there is more than this; there is, in essence, an appeal that values in education be based, not on glamour, not on current popularity, not on curriculum content as such, but – in substantial measure – on the degree to which an educational experience develops those qualities that are deemed most essential in meeting the problems of life itself.

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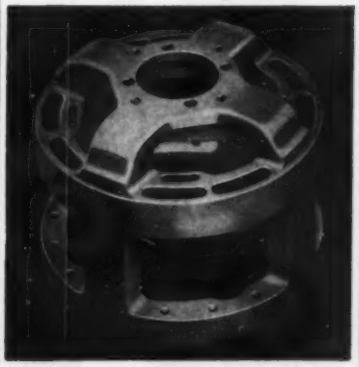

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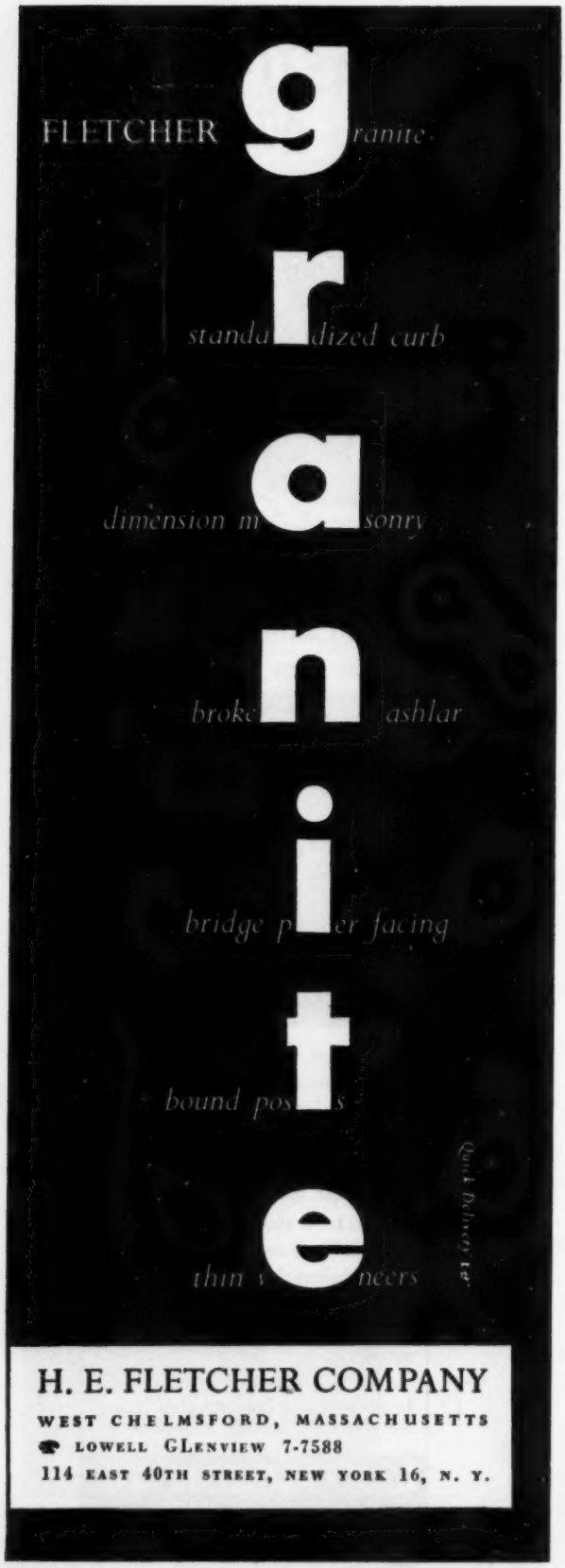

THE GREAT CONVERSATION

(*Continued from page 244*)

1. The secondary schools should take over more of the liberal arts training now given in college. "College Preparatory" courses should really prepare one for college. Under the title "Prescribed Mediocrity," *Time* in its issue of December 13, 1954, presented the views of John Latimer as follows:

Has the U.S. high school embarked on a retreat from solid learning? Absolutely, says Classicist John Francis Latimer of George Washington University. Latimer feels that he has evidence to prove his point. Among the results of a poll he took of 104 public-school systems in 44 states:

The number of secondary students studying languages has dropped from three out of four in 1900 to one out of four today. French has dropped from 8% to 5%, German from 14% to 1%, Latin from 50% to 7%.

In 1900 at least four out of five students took mathematics. Today fewer than half the students do, and of these, 13% are taking "general mathematics," which Latimer calls "a preparation for nothing, as far as college is concerned." Biggest slump: algebra, down from 56% to 20%.

Since 1948 the sciences have dropped 8%, and in spite of all the hoopla about atoms, physics has suffered most. In 1900 four out of every 20 students took physics. Today's count: one out of 20.

What is taking the place of these traditional courses? Points out Latimer: "Group action subjects" which the student can often bull his way through without cracking a book. "We have gotten away from individual effort . . . By permitting the high schools to become the vocational bargain basements of education, we have insulted the student's intelligence and encouraged mediocrity by prescribing mediocre subject matter as an incentive for mediocre minds."

2. In technical schools the humanities should be optional. There is no demonstrable proof that they ever made men more democratic. I am quite sure that Davy Crockett was every whit as patriotic as Thomas Jefferson – and a better shot. Love of freedom, I believe, is an innate burgeoning, and needs no didactics, anymore than it requires a traditionalist to stand before a bush in the springtime, holding out one of last year's withered leaves as a model. Dr. Hutchins, in one of his less happy phrases has said that liberal arts education should be "interminable." I agree with him – and also with Plato, who thought

(*Continued on page 262*)

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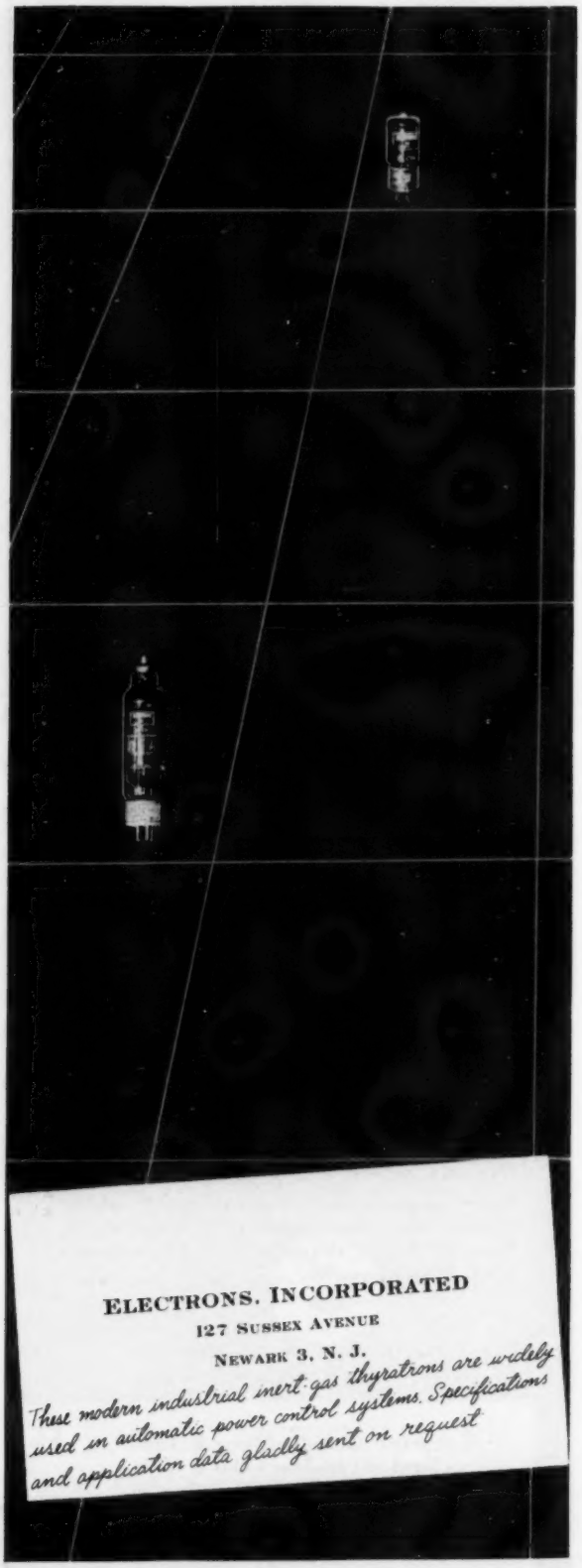
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THE GREAT CONVERSATION

(*Continued from page 260*)

that the study of philosophy should begin around 40. There are now 102 colleges giving evening courses; and in its issue of November 15, 1954, *Time* reported that "in 1952–53, the Ford-sponsored Fund for Adult Education spent more than $9,000,000 on every sort of project, from the American Library Association's American Heritage Program . . . to the Great Books Foundation's seminars . . ." There are no grounds for the slightest fear of culture withering away. But this is true: only in a college can a boy get technical laboratory training, and if he doesn't get it early, he is not likely, or able, to come back for it.

3. In this crisis, we should offer inducements to prospective engineers. In Russia, very serious efforts are made to find technological talent; engineering students are exempt from military service, since in Russia engineering *is* military service, and the nation offers cash subsidies to students of technology. Our government might put engineering and scientific training on the same footing as West Point and Annapolis; selected students would be enrolled in any of the fine technical schools we have and given cash allowances, with the proviso that upon graduation, they will serve an allotted time in government service. The method of awarding scholarships in our colleges should be revised as far as possible. Less emphasis should be on brilliance, more on financial need.

4. We should consider a degree, possibly for two years of study, that would qualify recipients to serve as technicians. Many engineers perform chores below their skills, simply for lack of technical personnel.

5. We should restore the honor and prestige of the scientific calling, now sunk to such a low, that Albert Einstein, in a letter to *The Reporter* (November 18, 1954) says: "If I would be a young man again and had to decide how to make my living, I would not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a peddler in the hope to find that modest degree of independence still available under present circumstances." He is obviously oppressed by the excessive badgering to which scientists today are subject.

Needed is the recognition that science offers not only frontiers to be explored, but also the virginal beauty of a poem read for the first time. As Nobel

(*Continued on page 264*)

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THE GREAT CONVERSATION

(*Continued from page 232*)

prize winner Sir Edward Appleton expressed it in the *Bulletin of the Atomic Scientists:* "Perhaps the most striking fact about modern science, in its explorations ranging from the heart of the atom to the frontiers of the universe, is that, like poetry, like philosophy, it reveals depths and mysteries beyond . . . At any one moment we may have only a precarious hold on a temporary truth, and our consciousness of this ever urges us to seek new truths and new understandings . . . The pursuit of science presents to the human mind an enduring challenge on an endless frontier, quite apart from the material enrichment of mankind . . ."[18]

As this article is in preparation, the New York *Times* (November 29, 1954) announces that a grant from the Carnegie Corporation of New York has been made to M.I.T. for a study of Soviet scientists and their quality. Appended to the newspaper story is a local item: "Americans need not be fearful of reports that Russia is outpacing the United States in training engineers, Prof. Henry Wasser, acting co-ordinator of humanities at City College, said yesterday.

"The Soviet increase in engineer training, he said, is being achieved by eliminating the study of humanities from Russian technical schools. This, Dr. Wasser predicted, will result in creation of a class of 'pure' technicians lacking the broader wisdom needed to perform managerial and executive jobs. 'This may prove to be a factor in undermining Russian economy and industry,' said Dr. Wasser. He declared that education in this country tended to give engineering students more training in the humanities, and he warned against reversing this trend to match Russia's output of engineers."

I find it impossible to utter another word.

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(*Concluded on page 266*)

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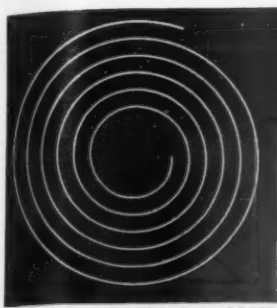

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THE GREAT CONVERSATION

(*Concluded from page 264*)

6. Robert M. Hutchins, *The Conflict in Education in a Democratic Society* (New York: Harper and Brothers, 1953).
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GRASS

(*Concluded from page 240*)

ing it, too." Grasses can be grazed in the field, and they also provide hay to enable the farmer to feed his cattle at low cost throughout the winter. And surprisingly enough, the cost of fattening chickens for market can be reduced considerably by feeding nourishing grasses with other feeds. Well-fertilized grasses, packed with nourishment, can provide from 75 to 80 per cent of the feed for dairy cattle, as many wise farmers have already learned to their profit.

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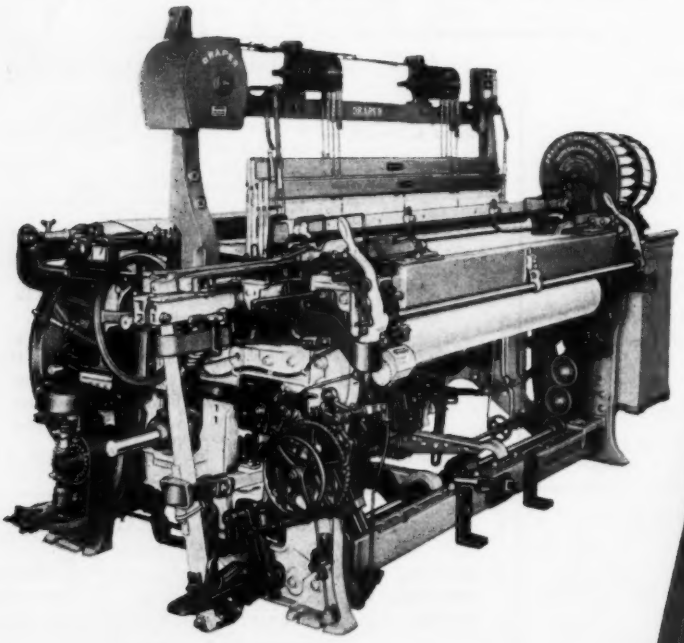

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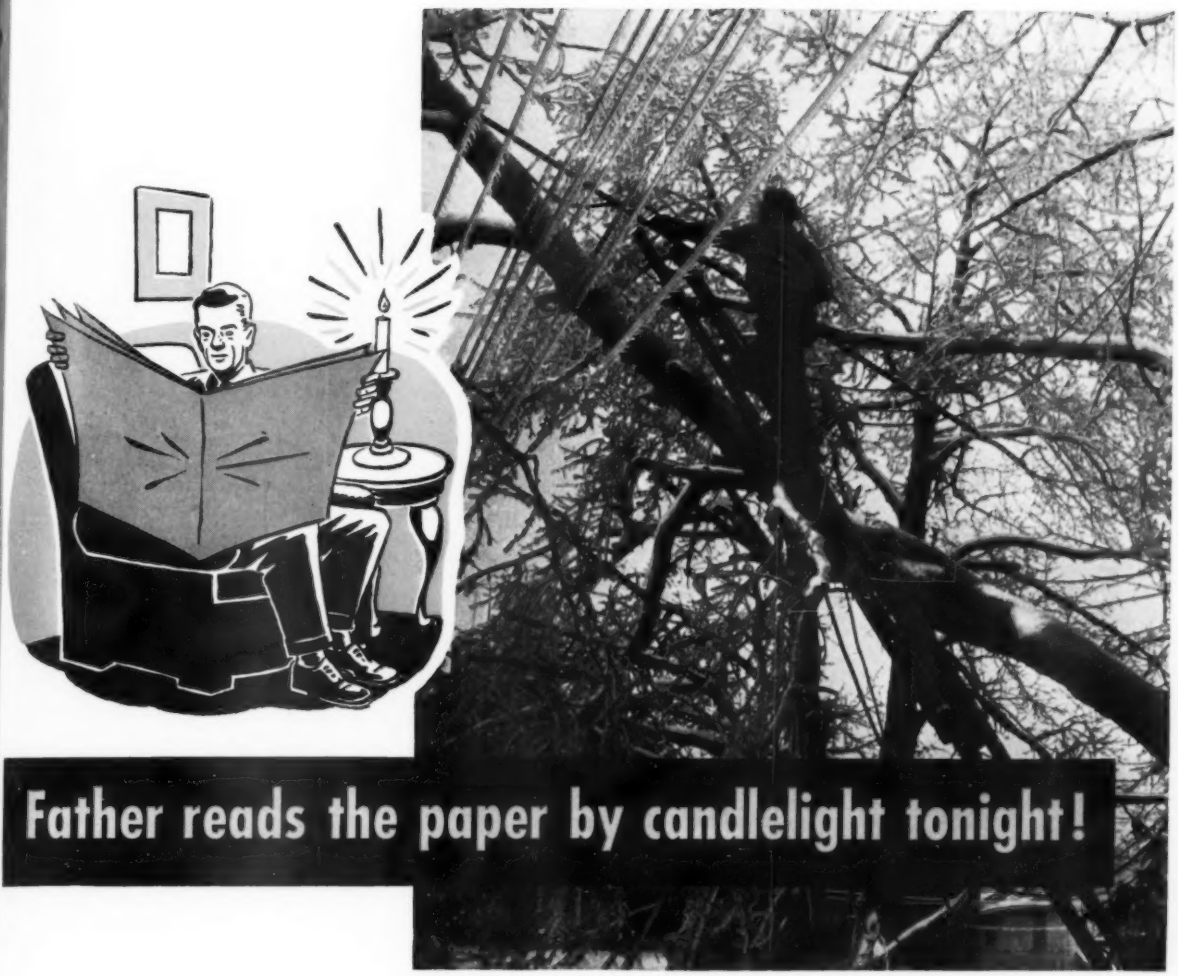

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